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Experimental Production of Shell Abnormalities in Turtles[1]

By W. Gardner Lynn and Sister Mary Coralie Ullrich S.S.N.D.

THE "shell" of the typical chelonian is a rigid armor consisting of bony plates covered with horny shields or scutes, both plates and scutes being arranged in characteristic patterns. Abnormalities in the number and arrangement of these parts occur quite frequently in nature and have been studied by Gadow (1899), Parker (1901), Newman (1906), Coker (1910), Hildebrand (1930), Babcock (1930) and Lynn (1937). A less frequent, but well-known type of abnormality is distortion of the shell resulting in turtles with humped backs or irregularly shaped carapaces or plastrons. Specimens exhibiting such distorted shells have been described by Hay (1904), Wandolleck (1904), Coker (1910), Newman (1923), Hildebrand (1930, 1938), Gressitt (1936, 1937), Cahn (1937), Deraniyagala (1939), Necker (1940), Mertens (1940), Fox (1941), Smith (1947) and Nixon and Smith (1949).

Various hypotheses have been advanced to account for these abnormalities. The occurrence of supernumerary scutes was regarded by Gadow (1899, 1905) as an atavistic reappearance of scutes that have been lost in the course of phylogeny. Coker (1905, a,b,c; 1910) strongly controverted this view and advanced the idea that extra scutes usually arise by division of single scutes during development and that such variatiors have no phylogenetic significance. Newman (1906) was in general agreement with Gadow and referred to scute abnormalities as "examples of systematic atavism in the sense of de Vries." With this concept as a starting-point he undertook the study of such abnormalities as a basis for elucidating the phylogeny of the Chelonia. Later, however (1923), he retracted this interpretation and suggested that scute and plate irregularities may be regarded "as the result of a minimal phase of twinning." Other authors have viewed such abnormalities as results of uneven healing of scutes scarred in brush fires (Knoll, 1935) or as possible indications of progressive steps in evolution (Berry, 1935). Deformities of the shell have been attributed to arrested development (Wandolleck, 1904; Hildebrand, 1930) and to pressure on the eggs resulting from crowding in the nest (Coker, 1910). None of these theories has been subjected to any experimental test.

The present paper is a report on some experiments that demonstrate that some of these types of abnormalities can be produced by subjecting the developing turtle egg to sub-optimal moisture conditions during certain critical stages.

Materials and Methods

During the course of experiments concerning the oxygen consumption of the turtle egg it was found that eggs exposed to partial drying during certain stages of their development often gave rise to hatchlings which exhibited

[1] A contribution from the Department of Biology, the Catholic University of America, Washington, D. C. This paper is based, in part, upon the junior author's dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science.

various types of abnormalities. To study this effect farther, several experiments were set up during the summer of 1945 using eggs obtained from the oviducts by dissection of 5 specimens of the eastern painted turtle (*Chrysemys picta picta*) and two specimens of the snapping turtle (*Chelydra serpentina serpentina*). The turtles were all collected early in the season, before the normal time for egg-laying, maintained in the laboratory until shelled eggs could be palpated in the oviducts, and then sacrificed. The eggs were kept in shallow dishes on a layer of moist cotton and were ordinarily kept covered by another layer of moist cotton. The usual egg complement in the painted turtle consists of only five or six eggs and for this species the eggs taken from each female were kept in a separate dish. The two snapping turtles yielded 37 and 48 eggs respectively and these eggs were divided into 10 groups containing 8 or 9 eggs each. At various times during the period of development the layer of moist cotton covering a batch of eggs was removed and left off until the eggs showed definite signs of drying out, the egg shell often becoming deeply dented. This usually required a period of 4 or 5 days. After this the surface layer of cotton was replaced and the eggs were allowed to develop to hatching. As a result of this rather crude experimental procedure it was found that a wide range of abnormalities could be produced and that the treatment was most effective in this respect during a period of about 15 days at the middle of development. In some the abnormalities produced were quite slight and the young turtles hatched normally, in others, hatching was delayed but was successfully accomplished, and in still others the embryos, although living and active, had to be removed from the egg. All were preserved in 10 percent formaldehyde for later study.

For the painted turtle eggs no strict controls were kept although several clutches of eggs taken from other individuals were maintained at the same time without being subjected to any drying and all of these produced normal young. In the snapping turtles, where more eggs were available, 8 eggs from each of the two clutches were carried as controls. In one group all 8 eggs gave rise to young turtles showing no abnormalities. In the other group 6 eggs hatched normal young. The other two were apparently unfertilized since no embryos could be found when the eggs were opened.

In addition to the abnormal young turtles which were produced as described above, 2 adult specimens showing typical abnormalities will be considered in this study. These were encountered in shipments of preserved turtles used for dissection and were received from a dealer in Wisconsin. They represent two different pond turtles, *Pseudemys scripta troostii* and *Chrysemys picta picta.*

Naturally Occurring Abnormal Adults

It has been pointed out that there are, in the literature, many records of shell abnormalities in adult turtles. As examples of the two main types of such abnormalities 2 specimens, which have not previously been described, are illustrated herewith.

An adult *Pseudemys scripta troostii* was received in this laboratory in November 1946 (Fig. 1). The carapace measures 232 mm. x 161 mm. The

scutellation is abnormal in that there are 8 neurals instead of 5 and the costals are increased to 6 on the right and 7 on the left instead of the usual 4. The specimen has the usual number of marginals (12 pairs) and a normal plastron. There are no abnormalities in the arrangement of the bony plates.

Another type of abnormality is illustrated by a specimen of *Chrysemys picta picta* in which, although the number and arrangement of both scutes and plates are normal, the shell is irregular in shape (Pl. I, Fig. 1, and Pl. II, Fig. 1). The carapace measures 127 mm. x 94 mm. It bulges on the right forming a wavy border and the plastron curves sharply to the right anteriorly. The right abdominal scute, because of this curvature, is reduced in size while the left abdominal is much enlarged. The distortion is confined to the right side and does not involve any bending of the vertebral column.

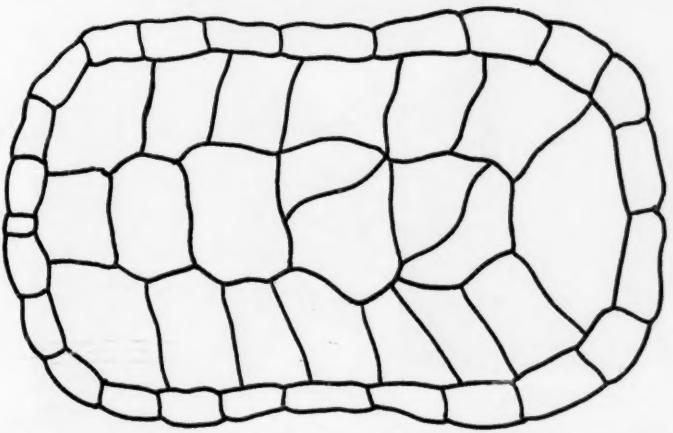

Fig. 1. Abnormal scutellation of the carapace in an adult specimen of *Pseudemys scripta troostii.*

Young with Experimentally Induced Abnormalities

In the experiments on sub-optimal moisture conditions it was found that eggs exposed to such conditions at any time during the first 35 days of development gave rise to very few abnormal hatchlings. Such eggs showed an unusually high mortality but those embryos which did survive until the time of hatching were nearly all normal. On the other hand, eggs which were exposed to partial drying at some time from the 35th to the 50th day of development had a lower mortality rate but a much greater frequency of abnormality. Relatively few of our experiments were carried out after the 50th day but those which were done at this time gave rise to few abnormal specimens. The average time required for incubation in our experiments was 63 days for the painted turtle and 72 days for the snapper. The indication

is that there is a certain critical period, near the middle of development, when partial drying of the egg is most likely to give rise to abnormalities.

The abnormal embryos produced in these experiments show a wide range of conditions from animals with very slight distortions of the shell to embryos with almost unrecognizable carapaces and plastrons, distorted limbs, and eyeless or jawless heads. A series of 7 hatchlings has been selected to illustrate this range and these will be described in detail.

The first example to be discussed is a newly hatched snapping turtle from a group of eggs which was subjected to partial drying during the 45th to 50th days of development (Fig. 2A and Pl. I, Fig. 2). This specimen hatched on the 71st day. It will be seen that the carapace is deeply indented on the right side in somewhat the same way as is that of the adult turtle (Pl. I, Fig. 1). The scutes of both carapace and plastron are normal in number and the feet, tail and head are well formed.

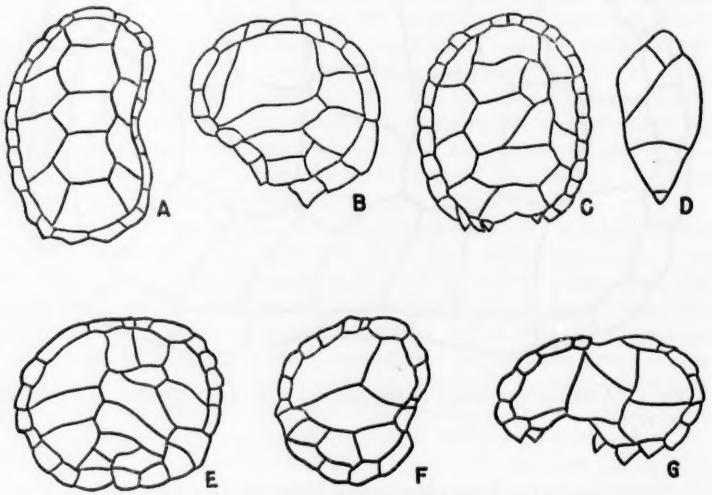

Fig. 2. Sketches of the scutes of the carapaces of the hatchling turtles shown on Plates I and II.

The second example is that of a painted turtle from a batch of eggs in which partial drying was carried out during the 47th to 50th days (Fig. 2B and Pl. I, Fig. 3). This individual did not hatch but was removed from the egg on the 70th day, 8 days after the untreated eggs of the same species had hatched. The carapace has only 7 marginal scutes on the right side and 8 on the left, 3 of the latter being curled over so that their ventral surfaces are seen in the photograph. There are 4 unusually broad neurals. The costals of

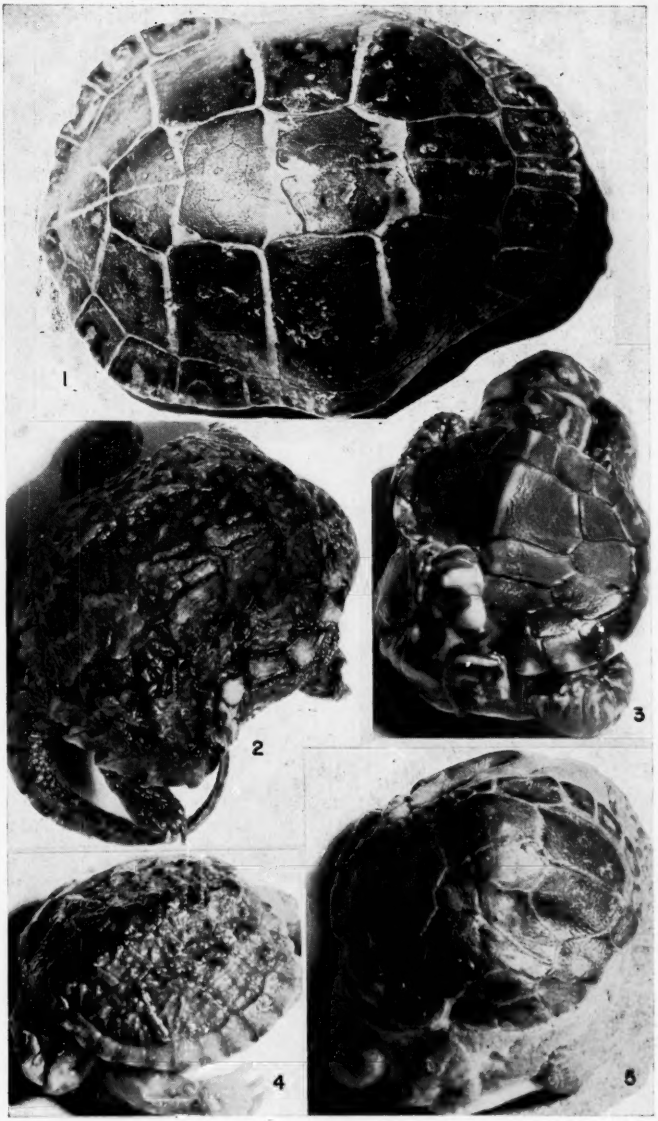

Fig. 1—Carapace of an adult *Chrysemys picta picta* (X ¾) showing distortion on the right side.

Figs. 2–5. Dorsal views of young turtles (X 2½) showing various types of experimentally induced abnormalities. Figs. 2 and 4 are specimens of *Chelydra serpentina serpentina*, Figs. 3 and 5, *Chrysemys picta picta.*

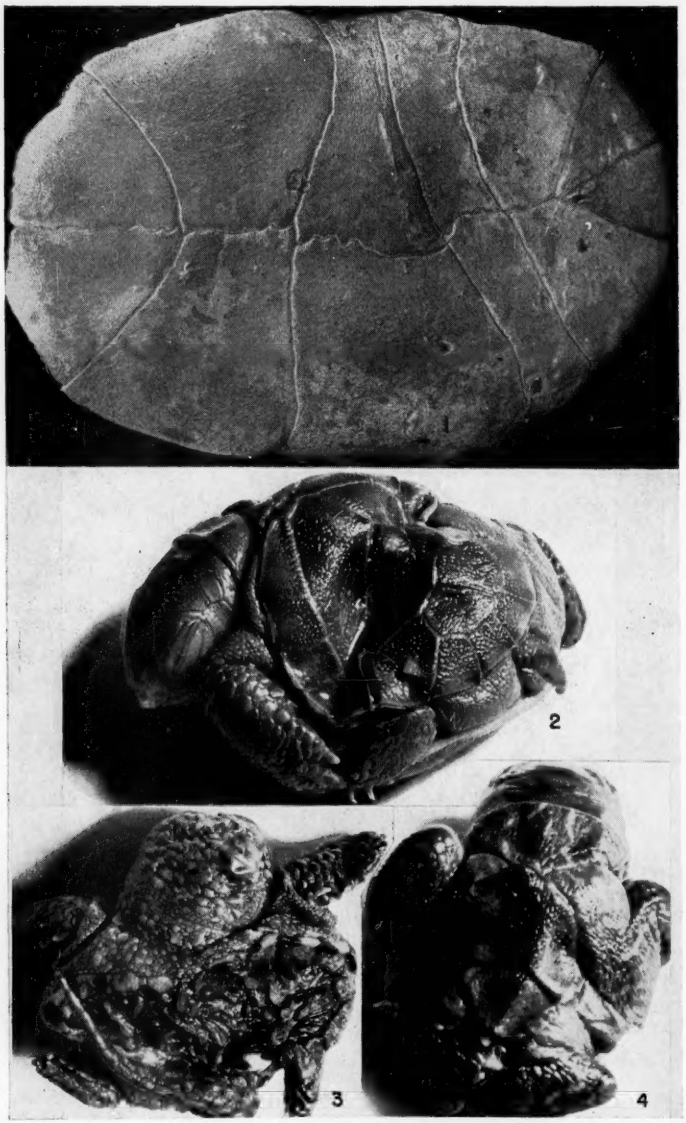

Fig. 1. Plastron of the adult specimen (X 1) whose carapace is shown in Plate I, Fig. 1.

Figs. 2–4. Young turtles (X 2½) showing experimentally induced abnormalities. Fig. 3 is a specimen of *Chelydra serpentina serpentina*, Figs. 2 and 4, *Chrysemys picta picta*.

the right side seem normal but there is only a single scute in the costal region of the left side. The plastron is symmetrical but has only 5 pairs of scutes, possibly because of fusion of the pectorals and abdominals. The animal has a distorted head which shows a condition resembling hare lip.

The third specimen illustrated (Fig. 2C and Pl. I, Fig. 4) is a snapper from the same group of eggs as the first example discussed. It hatched on the 70th day. The most obvious abnormalities in the animal are in the head which has a prominent protruding lower jaw but a poorly developed, eyeless upper jaw. It will be seen, however, that the specimen also has supernumerary scutes on the carapace. The neurals are 7 in number, apparently due to subdivision of neurals 2 and 3. There are 14 pairs of marginals but no nuchal.

In another painted turtle, from an egg exposed to drying during the 47th to 50th days, the carapace is broader than long and is asymmetrical (Fig. 2E and Pl. I, Fig. 5). The scutes are so irregular that the differentiation between neurals and costals is somewhat obscure. There seem to be 3 costals on the left and 2 on the right with 8 scutes in the central part of the carapace which may be classed as neurals. There are 10 marginals on the left side and 11 on the right, the 8th and 9th right marginals being enlarged so as to come into contact with the neurals. The plastron is relatively large but shows normal scutellation. The head and fore limbs of the specimen are normal but each of the hind feet has only a single digit.

Another painted turtle is from a batch of eggs exposed to partial drying from the 45th to the 49th days (Fig. 2F and Pl. II, Fig. 2). All five specimens of this group showed striking effects and were removed from the eggs on the 69th day. The individual illustrated has its carapace strongly curved to the left side. The scutellation is extremely abnormal, the neurals and costals being so irregular that they cannot be identified. The nuchal seems to be divided and there are 10 marginals on the left side but only 5 on the right. The plastron is also asymmetrical with 6 scutes on the right and 5 on the left. Head and appendages are normal.

An example of *Chelydra serpentina* from the same group of eggs as the first specimen discussed shows pronounced abnormalities (Fig. 2G and Pl. II, Fig. 3). Although given the same treatment these 2 individuals fall at opposite extremes with respect to abnormality. The head of this embryo is an eyeless, mouthless stump. The carapace is short and broad with such a disordered scutellation that only the marginals can be identified with certainty. Of these there are 9 on the right side and 7 on the left. This specimen was not able to hatch normally but was living and active when removed from the egg on the 75th day of incubation.

One painted turtle is from a set of eggs treated on the 40th to 43rd days (Fig. 2D and Pl. II, Fig. 4). It was removed from the egg on the 84th day. Most of the other individuals in this group were found to have died, this being one of 2 which survived. Those which died were well developed, however, and had doubtless succumbed because they were allowed to remain in the egg so long beyond the usual hatching time. The specimen shown here has a carapace so reduced in size that it covers only about one-third of the usual area and consists of but 5 scutes. The plastron is well formed and sym-

metrical but lacks one pair of scutes. Head and limbs are quite normal.

Discussion

As has been indicated, early studies on shell abnormalities in turtles led to the development of several theories concerning their origin. Gadow (1899, 1905) proposed the idea of "orthogenetic variation" mainly as a result of an investigation of the scutellation in young loggerheads, *Caretta caretta*. He maintained that young turtles often show greater numbers of supernumerary scutes than do older ones and therefore concluded that many young turtles begin life with a large number of scutes which are gradually reduced by fusion until finally the typical adult number is reached. He says "the ideal goal of a caretta is a sixteen-scuted shell, therefore, those turtles starting with more than the ideal number reduce them to sixteen" and "the changes necessary to turn any given variation into another one less abnormal until ultimately the normal condition is reached, are not erratic but stand in strict correlation with each other and proceed strictly on definite lines." The variations are thus "orthogenetic." Coker (1905, a,b,c), however, was unable to confirm Gadow's findings and reported no significant difference in the number of old and young specimens showing supernumerary scutes. He also found no indication of any regular fusion of scutes during development in the loggerhead.

Newman (1906), in a very comprehensive study of scute and plate abnormalities in a number of different species, came to regard these variations as atavistic in nature and therefore indicative of phylogenetic stages in turtle evolution. Thus, although not agreeing with Gadow that there is a reduction of scutes during ontogeny, he did nevertheless consider supernumerary scutes as of phylogenetic significance.

Meanwhile, however, there were various authors who tentatively advanced the hypothesis that unfavorable environmental conditions during development might account for at least certain types of shell abnormalities. Parker (1901) described several specimens of *Clemmys insculpta* in which both the horny scutes and the bony plates exhibited abnormalities in the same region. This correlation he regarded as evidence that the abnormality was produced early in development, so early as to affect both ectodermal and mesodermal derivatives. Again, Wandolleck (1904), in describing a strikingly distorted carapace of *Testudo graeca*, suggested that the condition might have resulted from a developmental arrest (*Wachsthumshemmung*) produced by either external or internal factors at some critical stage in development. This idea was later more fully elaborated by Stockard (1921) as an explanation for the origin of twins and double monsters. Hildebrand (1930) also invoked the theory of developmental arrest, possibly resulting from cool weather at a critical stage, to account for double monsters, variations in scutellation and distorted shells in turtles. Newman (1923) in describing nests of turtles found near Lake Maxinkuckee, Indiana, emphasized the importance of temperature relations as follows:

> I have examined a great many nests and have found whole batches of eggs dead and decaying, probably killed by a cold spell during the early periods of incubation. In other batches of eggs I have found a very large percentage of embryos abnormal in various respects: some with imperfect eyes; some with heads small

> and irregular; some with one or more feet lacking or tail lacking; some with deformed carapaces; many with irregularities of the scute pattern of both carapace and plastron, and associated abnormalities. All of these irregularities are obviously due to unfortunate developmental conditions, probably low temperatures.

Hildebrand (1938) suggested that changes in the available oxygen supply may be important factors in producing abnormalities in the diamond-back terrapin, *Malaclemys centrata,* for:

> Diamond-back Terrapins lay and pack eggs in such a way that considerable air space remains around the eggs. However, if the sand is too dry when the eggs are laid it may not 'stand up' but crumble and fall in all the intervening spaces. In that event the eggs would get insufficient oxygen. All these factors and many others contribute to the origin of chelonian twins and monstrosities.

Coker (1910), in studying nests of the loggerhead, hit upon still another explanation for the genesis of abnormalities which deserves attention and which he stated as follows:

> As the shell of the egg is soft and, in its new-laid condition, not completely filled, it displays a characteristic movable dent, like a rubber ball incompletely filled with air. In the course of development the contents increase in bulk and the shell becomes filled out and spherical: it may even be tightly distended. . . . The degree of distension varies with external conditions. Distension generally takes place, and it may occur to an extreme degree. With a large number of eggs massed together deep under the sand, the swelling of the eggs must cause great crowding and considerable interpressure. In one nest, for example, the eggs were so distended that upon a single puncture of a shell with a needle, a fine stream of fluid would squirt out a distance of several feet and the shell burst widely in the hand. Even though many of the eggs that failed to develop shrank in size so as to be almost flattened against the sand, yet the pressure among those that developed was such that they lost their spherical shape and were somewhat flattened on the sides where they pressed against other eggs. . . . The possible influence of such a factor as this interpressure of eggs in the production of abnormalities of various kinds is not to be ignored. The indirect results of localized pressure on the developing embryo of other animals are well known, especially through such work as that of Spemann in the production of double-headed embryos and 'cyclopean defects.' It may not be a coincidence that two 'cyclopean' embryos developed in the nest just referred to and that almost all of the turtles were abnormal in scutes, and some in still other respects.

Coker's theory seems to have attracted little attention but Grant (1937) has pointed out that it could hardly account for abnormalities in all species of turtles. Grant's study of some 300 specimens of *Gopherus* revealed that about 10 per cent of the animals showed abnormalities. This form, however, has eggs with hard, brittle shells which would be "insusceptible to warping by any pressure they would normally receive."

The present experiments are, so far as the authors know, the first in which eggs experimentally exposed to unfavorable developmental conditions have been definitely shown to give rise to abnormalities of the same general types as those which have so frequently been encountered in nature. Although more extensive and more carefully controlled experiments would be necessary in order to make any statements concerning the exact degree of drying required to produce abnormalities and the exact period in development during which this treatment is most effective, it seems quite clear that partial drying of the eggs can produce modifications in scutellation, shell distortions and abnormalities of head and limbs. In view of the fact that turtle nests are ordinarily made in sandy soil with a relatively shallow cover-

ing layer, it is easy to imagine that partial dehydration during hot, dry spells must often occur. Many eggs undoubtedly succumb when the drying is unduly prolonged but it seems quite probable that dry spells of just the proper duration, followed by normal rains, would frequently reproduce the conditions of the experiments described herein. Under such conditions one would expect that some of the embryos would be unaffected and would hatch normally, others would be strongly affected and would be unable to hatch at all, while still others would develop less serious abnormalities and would survive to give adults of the type described earlier in this paper.

As a matter of fact it appears likely that some of the cases adduced by Coker (1910) as evidence for the influence of interpressure might, with equal cogency, be ascribed to the effects of drying. In one group of eggs he found one animal with an asymmetrical and misshapen carapace and 2 with deformities of the head. One of the latter is described as having fused eyes and nostrils, a short upper jaw and a protruding lower jaw, while the other lacked eyes, had a carapace with only 2 scutes and possessed an extensive umbilical hernia. In discussing the history of this lot of eggs Coker said: "Some of them had dried somewhat and the lot was regarded as unpromising. However, they were placed in a single nest on the island made as usual in imitation of a natural nest. The spot chosen proved to be rather more moist than usual. During development the eggs swelled to an unusual degree. As a result they were very much crowded and were misshapen." Obviously these abnormalities may have been produced by the early drying rather than the later excessively moist conditions.

Although no experiments have been carried out on turtle eggs possessing rigid shells, we believe that partial drying would be equally effective in these forms for we do not conceive of the effect as being a mechanical one due to pressure from the collapsed egg shell. Although, in the eggs used in this experiment, the shells did often become deeply indented during the drying period, they did not always do so, and moreover there seemed to be no correlation between the extent of collapse of the shell and the degree of abnormality resulting. Where shell distortions were the only effects produced one may suppose that the water loss may have caused the embryo to be pressed down upon the yolk and that various abnormalities were then produced depending upon the exact position of the animal. More fundamental effects such as abnormalities in scutellation, agenesis of head structures, etc., do not seem explicable on a simple mechanical basis however, and in such cases one must assume a direct influence of the dehydration upon developmental processes. Further experimentation will be necessary before the details as to the factors involved in the effect can be fully elucidated.

Summary

1. Eggs of the painted turtle and the snapping turtle were exposed to sub-optimal moisture conditions at various times during their development.

2. Eggs so treated during early stages showed an increased mortality rate but most of those that developed to hatching gave rise to normal young turtles.

3. Eggs treated at some time during the period from the 35th to 50th day of development showed a slightly increased mortality but also produced a high percentage of abnormal embryos.

4. The abnormalities produced were of various degrees ranging from slight anomalies in the scutellation to markedly distorted, eyeless monstrosities.

5. It is suggested that many of the abnormal adult turtles described in the literature, which show conditions exactly paralleling some of the specimens produced in these experiments, have arisen through partial drying of the egg during a critical stage of their embryonic development.

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Intergradation in Appalachian Salamanders of the Genus *Plethodon*[1]

By NELSON G. HAIRSTON

THE classical picture of the distribution and taxonomic arrangement of the large species of *Plethodon* of the Southern Appalachians was of five distinct species. Three of these showed an allopatric distribution. They were *jordani*, *shermani*, and *metcalfi*, all confined to high altitudes in the Great Smoky Mountains, the Nantahala Mountains, and the Blue Ridge, respectively. *Plethodon glutinosus* was separated altitudinally from them, but was found throughout the area, and *P. yonahlossee*, a more primitive species, was thought to be confined to higher elevations in the northeastern part of the Southern Blue Ridge Province. This logical arrangement was used from 1912 through 1940, and as long as collecting was more or less confined to type localities, was one that fitted the known facts admirably. As the territory became more accessible, and more collectors became interested, certain facts were pointed out that were inconsistent with this picture. Bailey

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(1937) called attention to the variability of *P. glutinosus* and of *P. metcalfi*, and Bishop (1941: 18) found specimens that he considered to be intergrades between *shermani* and *glutinosus*. Bishop also resurrected *P. clemsonae*, which Brimley had described in 1927, and in so doing opened to question the hypothesis of mountain-top isolation, as this species is found at decidedly low elevations. Grobman (1944: 293) used *clemsonae* to include all of the southern populations from Rabun Bald, Georgia, to Swannanoa, North Carolina, thus calling attention to the fact that salamanders previously called *metcalfi* differed from the northern ones in their much darker belly-color. Hairston and Pope (1948) split the *clemsonae* of Grobman into three subspecies, which were connected with *shermani* by intermediate material from the extreme southeastern Nantahala Mountains. On the basis of fresh topotypic material, these authors restricted *clemsonae* to a small area at the headwaters of the Keowee River in South Carolina. Their two new forms were named *rabunensis*, from northern Georgia, and *melaventris*, including all of the remaining dark-bellied "*metcalfi*."

All authors up to the present have continued to regard *P. jordani* and *P. metcalfi* as distinct species. This was at least partly based on King's statement that he had taken the two "less than a mile apart" and was convinced that there was no intergradation (King, 1939: 553). Material collected by the author during the summer of 1949 indicates that all of the forms heretofore known as the *jordani* or the *metcalfi* group are connected by intergrades.

I am indebted to Arthur Stupka, Park Naturalist, Great Smoky Mountains National Park, and to John Y. Eller, Assistant Ranger, Pisgah National Forest, for co-operation in connection with the field work. Charles F. Walker and Norman Hartweg of the University of Michigan Museum of Zoology kindly read the manuscript and gave helpful suggestions.

Description of New Material

Hyatt Ridge, Great Smoky Mountains National Park, Swain County, North Carolina.—Plethodon metcalfi and *P. jordani* differ in the following characters: the color of the cheek, which is at least partly red in *jordani*, and grey in *metcalfi;* the color of the belly, which is black in *jordani*, and pale grey in *metcalfi;* and the intensity of black on the cheek, which is similar to the adjacent parts of the head in *metcalfi*, but not in *jordani*, which may almost lack the black (when present, it lies on top of the red). The result of this last character is that in *jordani* the paler cheek contrasts markedly with the top of the head, whereas this is not true in *metcalfi*.

A series of 19 specimens from Hyatt Ridge[2] seems to fill all of the requirements of intergrades between the two forms. Five of the 19 have some red on the cheek. In all of them, this is reduced in amount as compared with typical *jordani*, although it should be noted that *jordani* is somewhat variable in this regard. In 3 of the 5 specimens, the red is reduced to a few stellate areas, and on one of these, only the left cheek is so marked. As regards the amount of black on the cheek, this seems to be something of a subjective character,

[2] Table I contains museum catalog numbers and other pertinent data for all specimens referred to in the text.

since it is judged by the degree to which the cheek contrasts with the adjacent top of the head. The specimens in question show gradations in this contrast, and it is most marked in a specimen that lacks red entirely. The 19 specimens show various intensities of pigmentation on the belly, and in general are intermediate between *metcalfi* and *jordani*.

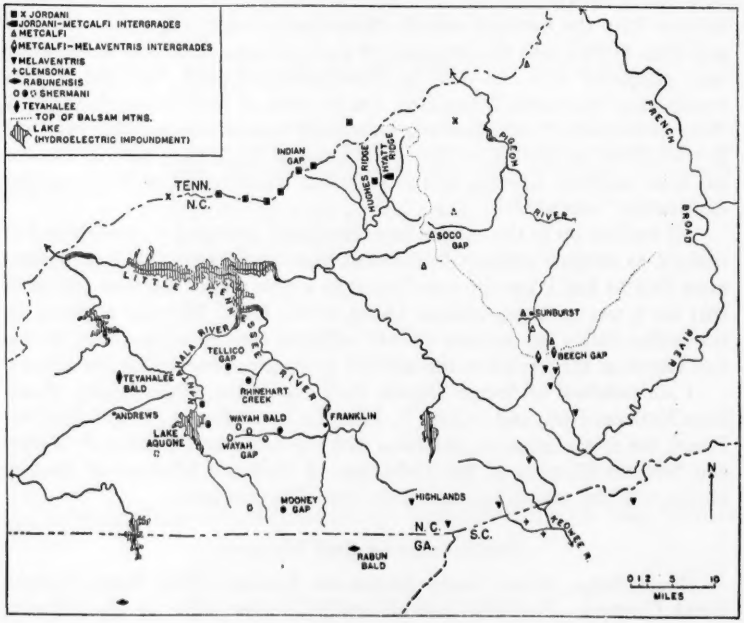

Fig. 1. Map of western North Carolina and adjacent areas, showing localities referred to in text, except Grandfather Mtn., northeast, and Swannanoa, east of the area shown. Solid symbols represent specimens with dark bellies; open symbols, those with pale bellies. Symbols with broken outlines represent literature records.

Within this series from Hyatt Ridge, the three characters analyzed are not correlated. Thus, 3 of the 5 specimens with red on the cheeks had relatively pale bellies and showed little contrast between the cheek and the top of the head. Eight of the 12 darkest specimens showed neither red cheeks nor marked cheek-contrast. The specimens are not only intermediate in the degree to which they show the characters of *jordani*, but the characters vary independently of each other among the 19 specimens. In order to show the position of this series as compared with typical material, all of the 17 adults were mixed in a pan with 31 adults of *metcalfi* from Grandfather Mountain, North Carolina (location of Brimley's paratypes), and with 26 adults of *jor-*

TABLE I

COLLECTION DATA, MUSEUM CATALOG NUMBERS, AND SUBSPECIES DESIGNATIONS OF SPECIMENS REFERRED TO IN TEXT

UMMZ: University of Michigan Museum of Zoology; CNHM: Chicago Natural History Museum; GSMNP: Great Smoky Mountains National Park Collection

Subspecies and Location	Elevation	Museum and Catalog Number	Number of Specimens
jordani			
Great Smoky Mountains			
Indian Gap	5100(?)	UMMZ 99101	2
" "	5300–5600	UMMZ 95394	1
" "	5300–5600(?)	UMMZ 95395	10
Newfound Gap	5500	UMMZ 75509	1
" "	5000	UMMZ 77377	10
Clingman's Dome	6643(?)	UMMZ 99102	1
Mt. Buckley and Double Spring Gap	5900	UMMZ 82758	1
Hughes Ridge	3700–3800	GSMNP Pj 90–95	6
jordani x *metcalfi*			
Great Smoky Mountains			
Hyatt Ridge	3940–4400	GSMNP Pm 20–38	19
metcalfi			
Grandfather Mountain	4000–5800	UMMZ 76262	43
Balsam Mountains (North Slope)			
Lickstone Ridge above Sunburst	4850–4900	UMMZ 100765	24
" " " "	5100	UMMZ 100763	2
" " " "	4750	UMMZ 100764	1
Middle Prong, W. Fork, Pigeon R.	3875	UMMZ 100781	4
" " " " " "	3750	UMMZ 100782	3
Left Prong, W. Fork, Pigeon R.	4525	UMMZ 100767	1
" " " " " "	4900–4950	UMMZ 100761	9
Soco Gap	4337	UMMZ 100770	12
" "	4550–4650	UMMZ 100771	12
metcalfi x *melaventris*			
Balsam Mountains (Top)			
Devil's Courthouse Mountain	5520–5680	UMMZ 100755	8
Tennessee Bald	5500–5520	UMMZ 100757	18
Beech Gap	5300	UMMZ 100758	7
Black Mountain	6000–6100	UMMZ 100768	40
Horsebone Gap	5300	UMMZ 100769	1
melaventris			
Balsam Mountains (South Slope)			
North Fork, French Broad River	3000–3050	UMMZ 100783	6
Road, Rosman to Gloucester	2365	UMMZ 100784	3
Tennessee Ridge	4425	UMMZ 100787	3
" "	5025	UMMZ 100789	1
" "	5215	UMMZ 100791	1
Courthouse Creek Road and Trail	3400–3525	UMMZ 100794	2
" " " " " "	3950–4050	UMMZ 100796	12
" " " " "	4200	UMMZ 100797	2
" " " " "	4500	UMMZ 100798	5
shermani			
Nantahala Mountains			
Road, Franklin to Wayah Gap	2500	CNHM 59889	1
Beside Lake Aquone	3000	UMMZ 100774	1
" " "	3000	UMMZ 100775	1
" " "	3000	UMMZ 100776	1
East of Nantahala River	2850	UMMZ 100780	3
Rhinehart Creek	2800	UMMZ 100802	1
" "	3100	UMMZ 100803	1
Tellico Gap	3950–4000	UMMZ 100805	5
" "	3750	UMMZ 100806	2
teyahalee			
Snowbird Mountains			
Teyahalee Bald	4525	UMMZ 100807	1
" "	4525	UMMZ 100808	1
" "	4375	UMMZ 100810	1
" "	4375	UMMZ 100809	1
" "	4000	UMMZ 81040	3

dani from the vicinity of Indian Gap, Great Smoky Mountains, the type locality. An additional 5 adults of *jordani* from Hughes Ridge, just west of Hyatt Ridge, were included. The 79 specimens were then graded according to belly-color, regardless of their geographic origin. Following this, they were mixed again and graded in a similar fashion for cheek-contrast. Each specimen thus has an independent position in the two lists, and from this information Figure 2 was constructed. In the figure, "ideal" *jordani* would occupy the upper right corner, "ideal" *metcalfi* the lower left. Although this sorting is not

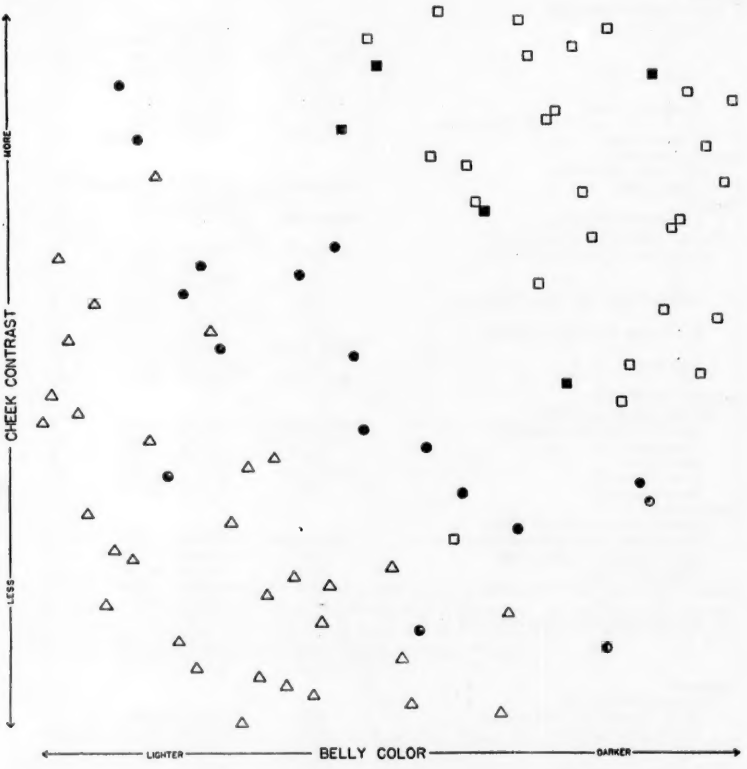

Fig. 2. Comparison of *Plethodon jordani jordani, P. j. metcalfi*, and intergrades between them. Triangles represent *metcalfi*, circles intergrades, and squares *jordani*. Solid squares represent specimens from Hughes Ridge; open squares, those from near Indian Gap. Circles partly white show variations in amount of red on cheeks.

as desirable as using an objective criterion, it nevertheless gives a good impression of the true position of the individual specimens. The position on the

chart of the series from Hyatt Ridge confirms the general impression of their intermediate nature. The specimens are to be considered integrades between *jordani* and *metcalfi*.

Balsam Mountains, Haywood, Transylvania, and Jackson counties, North Carolina.—In choosing his type of *metcalfi*, Brimley (1912) designated a specimen from near Sunburst, Haywood County, North Carolina, without realizing that this locality lies close to the boundary between a northern, light-bellied population and a southern dark-bellied one. This distinction was first recognized by Bailey (1937), who associated it with altitude. Grobman (1944) pointed out the geographic relationship, and decided that the name *metcalfi* should be retained for the light-bellied form. Besides color, the two forms differ in size, *melaventris* being larger, and degree of sexual dimorphism, which is more marked in *metcalfi* (Pope and Hairston, 1948; Hairston and Pope, 1948).

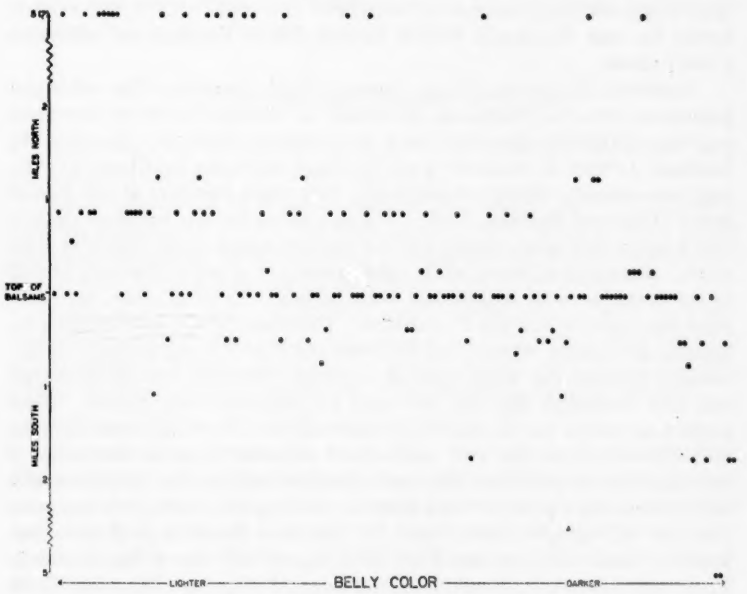

Fig. 3. The relation between belly-color and distribution along a north-south axis in *Plethodon jordani metcalfi* and *P. j. melaventris*.

Sunburst lies at the foot of the Balsam Mountains on the north side (Fig. 1); its elevation is 3031 ft. A large series of plethodons was collected near Sunburst, across the top of the mountains at and near Beech Gap, and down the south side into the range of *melaventris*. Taken as a group, these specimens show wide variation in the intensity of black pigment on the belly. They were sorted for belly-color in the same fashion as the *metcalfi-jordani*

intergrades (see above), and their relative positions were then plotted on a chart, the abscissa being their position in this series, the ordinate being their location along a north-south line across the mountain (Fig. 3). Added to this series was another from near Soco Gap, also in the Balsam Mountains, but farther north than the known range of *melaventris*. It is problematical just where to place these Soco specimens on the north-south line, but they should unquestionably be placed farther north than any of the others. An examination of the figure shows that there is much variation in belly-color among specimens from any given locality, but it is also clear that there is a general trend for the northern specimens to be paler, the southern ones darker. This is independent of elevation, as the series from the middle of the north-south line came from higher altitudes than did those from either side. The variability within each collection and the failure of the whole series to fall into two distinct groups indicate that there is a subspecific relationship between *metcalfi* and *melaventris*. It is assumed that the top of the Balsam Mountains is approximately centered in the zone of intergradation. This zone could hardly be near Highlands, Macon County, North Carolina, as Mittleman (1948) stated.

Nantahala Mountains, Macon County, North Carolina.—The red-legged population from the Nantahala Mountains is controversial in its taxonomic position. Originally described as a full species, *Plethodon shermani*, by Stejneger (1906), it was made a subspecies of *glutinosus* by Bishop (1941), and more recently linked subspecifically with other members of the *jordani* group (Pope and Hairston, 1948). Bishop's allocation was based on the fact that a series from near Aquone differed from topotypes in the following characters: possession of lateral white spots; reduction of red on the legs; ground color; vomerine tooth counts; and shape of head. In all of these, the specimens were more or less like *P. glutinosus*. Grobman (1944) rejected the relationship for various reasons, and Hairston and Pope (1948) pointed out differences between the white spots of topotypic *shermani* and of *glutinosus*, and also concluded that the two were not subspecifically related. These authors accounted for the dark belly and reduction of red by assuming prior (Pleistocene) connection with *jordani* and *melaventris* across the valley of the Little Tennessee River. The new collections indicate that specimens with red legs may have either or both kinds of white spots. Such specimens come from the following locations: near the road from Franklin to Wayah Gap, 2500 ft.; beside Lake Aquone, 3000–3050 ft.; one mile east of the Nantahala River on the road from Franklin to Andrews, 2850 ft.; near Rhinehart Creek in the northeastern part of the Nantahalas, 2800–3100 ft.; and at Tellico Gap at the north end of the Nantahala Range, 3750–4000 ft. (Fig. 1). All of these have darker bellies than do topotypes, and some of them have the red on the legs greatly reduced; most have varying amounts of white on the sides of the body. Of considerable interest is the presence of red cheeks on 3 specimens: one from beside Lake Aquone, one from near the Nantahala River, and one from Tellico Gap. The significance of these collections is considered in the discussion.

Snowbird Mountains, Cherokee and Graham counties, North Carolina.—Grobman (1944: 289) has called attention to the absence of records from

the Snowbird Mountains to the north and west of the range of ***shermani,*** and suggests the possibility of a new representative. A series of 3 adults and one juvenile from Teyahalee Bald (Johanna Bald), 4375–4525 ft., seems to fulfill Grobman's suggestion. All 3 adults in life showed on sides, cheeks, and throat "numerous irregular blotches of a yellow-green color, reminiscent of, but not exactly like the 'brassy' of *P. s. clemsonae*" (quotes from my field notes). One of the 3 has a few tiny flecks of red on 3 of the legs. Bailey (1937: 3) described 3 specimens from Teyahalee Bald, 4000 ft.; these he assigned to *P. glutinosus,* although one of them "lacked the normal white pigment completely." A re-examination of these specimens reveals that all have white spots, although the largest has them much reduced. On the left humeral region of this specimen, there is a very small spot that lacks black chromatophores, and strongly resembles the red spots found on the legs of atypical *shermani.* Long preservation makes absolute determination of the color inadvisable.

The distinctive greenish-yellow spots on all 3 of my adults leads me to consider them as belonging to a distinct subspecies:

Plethodon jordani ***teyahalee,*** subsp. nov.

DIAGNOSIS.—A dark-bellied subspecies of *Plethodon jordani* with irregular greenish-yellow spots on cheeks and sides.

TYPE.—University of Michigan Museum of Zoology, No. 100807, a male from an elevation of 4525 ft. on Teyahalee Bald (= Johanna Bald) in the Snowbird Mountains on the boundary between Graham and Cherokee counties, North Carolina, collected by the author, August 23, 1949.

PARATYPES.—UMMZ No. 100808, adult female collected with the type; UMMZ No. 100809, adult male, data same as for type, except elevation 4375 ft.; UMMZ No. 100810, juvenile, data same as for No. 100809; UMMZ No. 81040, 2 males and one juvenile from Teyahalee Bald, elevation 4000 ft.

RANGE.—Known only from the type locality.

DESCRIPTION OF TYPE.—An adult male, 126 mm. in total length (tail regenerating), 72 mm. from snout to anterior angle of vent; 16 costal grooves, counting one in the axilla and 2 in the groin; 2 intercostal folds between the adpressed toes; vomerine teeth 10 – 7. The ground color is very dark grey above, becoming only slightly paler below. There are (March, 1950) traces of irregular light spots on sides, cheeks, and on the throat anterior to the gular fold. Described in life as follows: An adult male, with tip of tail regenerating. Ground color black above and below; on the cheeks and extending onto the lower jaw and throat anterior to the gular fold are numerous irregular blotches of a yellow-green color, reminiscent of, but not exactly like the "brassy" of *P. s. clemsonae.* A few of these spots extend along the sides back to and including the base of the tail. No other color present (a few of the spots on the right hind leg).

VARIATION.—One paratype (UMMZ No. 100809) has red flecks on 3 legs, and some of the lateral spots are silvery white, instead of greenish yellow; another (UMMZ No. 81040) apparently has a red spot on one leg; only white

spots remain on 4 of the paratypes (UMMZ No. 100810 and No. 81040).

Discussion

Taxonomic Arrangement.—The evidence presented here and elsewhere (Hairston and Pope, 1948) leaves little ground for regarding the seven allopatrically distributed members of the present group as anything but subspecies. The evidence favoring subspecific status between *shermani, rabunensis, melaventris,* and *clemsonae* has been presented in the above-mentioned paper. The intergrades between *metcalfi* and *jordani,* and between *metcalfi* and *melaventris,* have been described above. Red on the legs of some specimens of *teyahalee* apparently links this form to *shermani.* It is possible to argue that some of the intermediate specimens represent hybridization rather than intergradation. However, the allopatric distribution of the forms, and the discovery of numbers of individuals intermediate in character wherever marginal areas have been investigated, indicate continuing subspecific status. The 3 red-cheeked and red-legged specimens from the range of *shermani* must be interpreted with caution, in view of the similar situation in *Desmognathus ochrophaeus carolinensis* (Brimley, 1928; Bishop, 1947; Hairston, 1949: 59), but the obvious explanation for them is that they represent the remains of intergradation between *jordani* and *shermani,* probably at some time during the Pleistocene. This interpretation is not necessary for the allocation of *shermani* as a subspecies of *jordani,* as the two are connected via *metcalfi, melaventris,* and *rabunensis.* The 3 specimens of *shermani* are here viewed as merely additional evidence for a subspecific status. It is noteworthy that all are from northern localities and are thus geographically close to *jordani.* None of 70 or more specimens from Wayah Bald and southward in the Nantahalas to Mooney Gap showed any red on the cheeks.

A difficult view to dispose of is the reported intergradation between *shermani* and *glutinosus* (Bishop, 1941: 18). The difficulty lies in the establishment of absolute criteria distinguishing *glutinosus* from the *jordani* group as a whole. Hairston and Pope (1948: 269) thought that there was an absolute difference in the white spots. As stated above, more recent collections indicate that red-legged salamanders may have both kinds of spots, and this character fails also. The distribution of the puzzling specimens is of considerable significance. If interbreeding with *glutinosus* were responsible for atypical *shermani,* these should be concentrated at low elevations. Bishop gives the location of his specimens as one mile northeast of Aquone near Wine Spring Creek. The site of Aquone is now covered by Lake Aquone, but Bishop's specimens would have come from around 3000 ft.—satisfactorily low. Similar specimens, however, are found over a vertical range of 2000 feet, from 2500 ft. on the road from Franklin to Wayah Gap to 4500 ft. at Mooney Gap (see list, above, and Hairston and Pope, 1948). There is one distributional feature that they do possess in common, as examination of the map (Fig. 1) shows. This feature is that they are all located in peripheral parts of the range. Now, *shermani* is a light-bellied form, at least partly surrounded by dark-bellied members of the *jordani* group: on the south and southeast by *rabunensis;* on the east by *melaventris;* on the north by *jordani;*

and on the northwest by *teyahalee*. It is also true that the low-altitude, dark-bellied *glutinosus* completely surrounds *shermani*, and one must reason from available evidence which interpretation to give. There are several interpretations possible:

1. Bishop's assumption that *shermani* is a local race of *glutinosus*, necessitating the subspecific status *P. glutinosus shermani*. This ignores a wealth of information placing *shermani* in the *jordani* group: a) specimens intermediate with *rabunensis* on the border of the ranges of the two; b) the marked similarity between the juveniles of *jordani* and *shermani* (Bailey, 1937: 5; Wood, 1947a and b); c) the allopatric distribution of *shermani* with other members of the *jordani* group (Dunn, 1926; Bishop, 1943; Bailey, 1937; Grobman, 1944; Hairston and Pope, 1948); d) specimens from the northern part of the range of *shermani* with both red legs and red cheeks.

2. Hairston and Pope's allocation of *shermani* as subspecifically related to *rabunensis*, *melaventris*, and *clemsonae*. This interpretation is carried to its extreme in the present paper, all seven members of the group being regarded as subspecies.

3. The possibility that *shermani* intergrades with both the *jordani* group and *glutinosus*. The logical extreme of this interpretation would be to regard all as subspecies of *glutinosus*. In this case, it is important to consider the relationship of *glutinosus* with the other members of the *jordani* group. The ecological relationships are discussed by Hairston (1949) and in a paper in preparation. The following have been studied in this regard: *jordani*, *shermani*, *metcalfi*, *clemsonae*, and *melaventris*. Except for *shermani*, there is not the slightest bit of evidence that any of these merge with *glutinosus* at elevations where they come in contact with it. The significance of these facts is as follows: if these are all subspecies of *glutinosus*, then we have an "open ring" that is open everywhere except at one point, or at most, three out of seven, as there is no information concerning the relationships between *glutinosus* and *rabunensis* or *teyahalee*. A more satisfactory view would be to regard any merging of *shermani* and *glutinosus* as true hybridization. If this view is taken, then the nomenclature would be the same as that indicated under No. 2, above.

4. There is finally the interpretation that all are simply allopatric species (Dunn, Bailey, Grobman). All of these works were written before the evidence of sufficient intergrades indicated a closer relationship. The inclusion of *clemsonae*, *rabunensis*, and *melaventris* within either *metcalfi* or *clemsonae* ignores such characters that are easily distinguishable in living material but disappear in preservative, with the result that excessive lumping is employed in some instances, whereas intergrades are overlooked in others.

Based on what seems to me the most reasonable interpretation of the available evidence, the nine large plethodons of the Southern Appalachians are best designated as follows:

Plethodon g. glutinosus (Green)
Plethodon yonahlossee Dunn
Plethodon jordani jordani Blatchley
Plethodon jordani shermani Stejneger
Plethodon jordani metcalfi Brimley

Plethodon jordani clemsonae Brimley
Plethodon jordani rabunensis Pope and Hairston
Plethodon jordani melaventris Pope and Hairston
Plethodon jordani teyahalee, subsp. nov.

There remains Mittleman's statement that he has collected a large, unmarked, black *Plethodon* from southeastern Kentucky (Mittleman, 1948). This simply remains a problem, and could either represent a local race of *P. glutinosus* (Grobman, 1944: 231), or possibly an undescribed subspecies of *jordani.*

Mode of Isolation of the Subspecies *jordani.*—Deevey (1949: 1369) has advanced the interesting hypothesis that the speciation and subspeciation of the large plethodons of the Southern Appalachians was initiated during the Pleistocene by chilling of the higher mountains and driving the various forms into isolation either in the separated valleys or onto the surrounding lower country. Thus, *metcalfi* could have been isolated in the valley of the French Broad River, *jordani* to the north of the Great Smoky Mountains, *shermani* in the valley of the Little Tennessee River, *teyahalee* near the Hiwassee River, and *melaventris, rabunensis* and *clemsonae* in different parts of the Piedmont. There are certain obvious objections to this detailed working out of Deevey's hypothesis (the details mine). These objections would be: What became of *shermani* to the north and east of the Little Tennessee River? What isolated the three forms on the Piedmont? These are no worse than the difficulties with the conventional hypothesis that the forms arose in isolation on the various mountain ranges. These difficulties would be: *P. j. melaventris, rabunensis,* and *clemsonae* are not confined to high elevations, and would not thus be isolated; the evidence presented above that *melaventris* and *metcalfi* intergrade across the top of the Balsam Mountains, with the implication that this range may once have been a barrier. It does not seem advisable at present to choose between the two hypotheses.

Deevey's conclusions regarding the recency of evolution of the Plethodontidae and of the earlier speciation of the large plethodons seem to the author to be less tenable for various reasons, but the present paper is not the place to discuss them.

Summary

Intergrades between *Plethodon jordani* and *P. metcalfi* are described; they were collected on Hyatt Ridge, Swain County, North Carolina, in the southeastern part of the Great Smoky Mountains National Park.

Intergrades between *Plethodon metcalfi* and *P. shermani melaventris* were found in the Balsam Mountains, on the boundary between Haywood, Transylvania, and Jackson counties, North Carolina, only a few miles from Sunburst, the type locality of *metcalfi.*

A new subspecies, *Plethodon jordani teyahalee,* is described from Teyahalee Bald (Johanna Bald) on the boundary between Cherokee and Graham counties, North Carolina.

The taxonomic arrangement of the large plethodons of the Southern Appalachians is discussed, and the conclusion is reached that *P. glutinosus*

and *P. yonahlossee* are properly regarded as full species, and the remaining seven (*jordani, shermani, metcalfi, clemsonae, rabunensis, melaventris,* and *teyahalee*) are best considered as subspecies of *P. jordani.* Bishop's allocation of *shermani* as a subspecies of *glutinosus* is rejected; if the two actually interbreed, a true hybridization would seem to be indicated, as *glutinosus* is not known to merge with any other subspecies of *jordani.*

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A New Bromeliad Frog from the Mexican State of Veracruz

By Edward H. Taylor

In the herpetological collections made for the University of Kansas Museum of Natural History by Mr. Walter W. Dalquest are certain hylid frogs belonging to an undescribed species. They inhabit bromelias at an elevation between 4500 and 5000 feet on the Gulf slope of the Mexican plateau. Eight of the specimens were taken in the month of December at Coscomatepec at an elevation of 5000 feet and two at Huatasco, one at 4500 feet and the other at 5000 feet elevation.

Since the females contain large ovarian eggs it is presumed that the breeding season occurs during December or at most, not later than January.

Hyla mixomaculata, sp. nov.

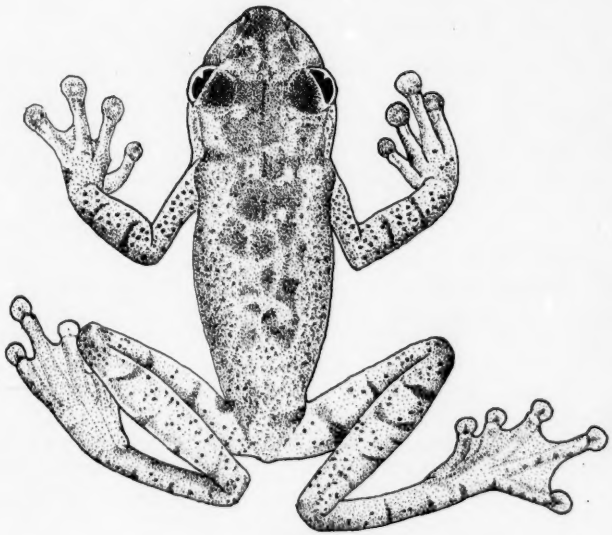
Plate I

Type.—Kansas University Museum of Natural History No. 26777, female from Coscomatepec, 5000 feet elevation, Veracruz, Mexico; collected December 1, 1948, by Walter W. Dalquest.

Paratypes.—KUMNH Nos. 26776, 26778–26780, 26782–26785, same data as type; 26781, 26786, Huatasco, Veracruz. Museum of Comparative Zoology, Harvard College No. 24806, Sumidero above Moctezuma, Metlac, Veracruz; collected by Archie Carr.

Diagnosis.—Tympanum concealed; anal flap not modified; snout blunt, the nostrils nearly terminal; canthus rostralis angular; vomerine teeth between choanae and reaching their posterior level; toes fully webbed; a distinct inner but no outer tarsal fold; heel to a point halfway between eye and nostril; males lacking nuptial asperities, and lacking vocal slits in the mouth; a diffuse glandular area on breast and chin in males.

Description of Type.—Head as broad or broader than body, its width nearly equal to its length (or in males slightly longer than wide), the neck narrowed immediately behind head; area about nostrils swollen, leaving a slight depression between nostrils on dorsal surface of snout; distance of nostril from eye equal to or minutely greater than its distance from the middle point on upper lip; muzzle extends very slightly beyond mouth, the nostrils nearly terminal; a sharply-defined, straight, or slightly curving canthus from eye to the swelling about nostril; loreal region not or but slightly concave, sloping obliquely to edge of lip. Eyes large, protuberant, directed slightly forward, the length of eye (4 mm.) practically the length of snout (4.1 mm.); the posterior, vertical, part of eyelid straight, without a distinct lobe; width of upper eyelid (2.8 mm.) smaller than interorbital width (3.8 mm.); tympanum covered, no trace of its outline visible; a well-defined fold from eyelid to above arm insertion. Choanae moderately large (0.9 mm.) separated from each other by a distance of 2.9 mm.; vomerine teeth in two fascicles lying between the posterior halves of the choanae, barely reaching their posterior level, separated from each other by a distance half as great as their distance



Hyla mixomaculata. Type, KUMNH No. 26777, Coscomatepec, Veracruz, Mexico. Actual length 34.5 mm.

from choanae; tongue large, slightly emarginate on posterior edge, and not or but very slightly free behind.

Skin above appearing smooth but under a lens is seen to be minutely corrugated, the roughest area being on dorsal surface of head; vent high, the anal flap especially short, the area about it fluted, without or with only slightly enlarged tubercles at some distance below opening. Venter and most of the under surface of the femur strongly granular; some indistinct granules on breast and chin.

Surface of arm slightly rougher than back; fingers with broadened discs; two outer fingers with distal subarticular tubercles bifid or double (sometimes that of third finger also); palm with a large metacarpal tubercle on base of first finger and a tripartite outer palmar tubercle or pad (scarcely distinguishable on one hand); outer fingers about one-third webbed, the digits flattened and edged with a ridge or "fringe" to disc; supernumerary tubercles small, indistinct for the most part; a continuous ridge or tubercular skinfold from near wrist to elbow under forearm.

Heel reaching a little beyond anterior edge of eye when leg is extended forward; a distinct, elevated, inner tarsal fold; no outer tarsal fold; foot almost completely webbed, web reaching to disc on outer side of first and second, and inner edge of fifth toe; a fold on outer edge of fifth toe not continued on tarsus; a small inner metatarsal tubercle and a diminutive, scarcely discernible, outer tubercle; when legs are folded at right angles to body, heels overlap 4 mm.

Color (in alcohol).—Dorsal surface very light brownish lavender with darker lavender spots; area on top of head largely dark colored; scattered minute dots on sides of head and body and on dorsal surface of limbs; arms and legs with narrow dusky bars; ventral surface of chin, breast, abdomen, and under side of femur and tibia light flesh (cream) with a slight scattering of pigment on edge of chin; under side of tarsus and foot largely light purplish; hand light, slightly pigmented; area about vent slightly darker, with some light-topped tubercles; a light line or spot on heel. Sides light, without distinctive lines or marbling.

Measurements.—(Table I.)

Table I

Measurements in mm. of Type and Five Paratypes of *Hyla mixomaculata*, sp. nov.

No.	26779	26777	26780	26783	26781	26782
Sex	♀	♀	♀	♀	♂	♂
Snout to vent	35	34.5	30	30	30	30
Snout to eye	4	4.1	4	4	4.1	4
Eye length	3.8	4	3	3.4	3.3	3.2
Head width	11.9	11.9	11	10.5	10.2	10
Head length	10	10.2	10	9.8	11	11
Arm	22	22	20	18	20	19
Hand	10.6	10.5	9.3	9.2	10.2	10
Leg, from vent	51	52	48	44	47	46
Tibia	16	16.5	15.3	15.2	15.5	15.3
Foot and tarsus	23	23	22	19.2	21	20.5

Remarks.—Field data do not include detailed color notes on living

specimens. One note on two specimens, Nos. 26783 and 26785, reads [taken in] "Bromelia; brick red"; the color referring to the specimens. Of another specimen a notation is made—"Reddish brown."

The two largest females listed agree in great detail. The dorsum of the body is strongly spotted with dusky brown and the sides of head and body have the tiny maculations. The arms and legs are distinctly barred with narrow dark lines, the intervening spaces between bars bearing numerous small dots similar to those on the sides.

In some of the other specimens (*i.e.*, No. 26778) the dorsal spotting is obsolete but the small dots are scattered over the back and on dorsal surfaces of the limbs. In all the specimens except the two largest females the dorsal and lateral snout surfaces are darker. A few of the specimens have some minute punctations on the chin or, in the case of the two males, there may be still more pigment around the outer part of the chin. In most of the specimens there is a slightly lighter area at the point where the tympanum should be, which at a glance suggests to the naked eye that a tympanum is present.

The amount of pigment on the undersurfaces of the palms and soles varies, seemingly being heaviest in the males. The feet are nearly fully webbed to the discs in all of the paratypes.

A specimen MCZ No. 24806 from "Sumidero above Moctezuma, Metlac, Veracruz," agrees in all essential details with the type specimen.

The relationship of this small species is thought to be with *Hyla taeniopus* from which it differs in the absence of white spots on the upper lip, black-bordered cream spots in groin and along sides (sometimes confluent into a broad cream stripe, sometimes discontinuous), longer limbs, more fully webbed feet, and the absence of the tympanum. Superficially it resembles *H. bromeliana* but that form is peculiar in having a greatly elongated anal flap, carrying the opening down to the level of the venter; in the species at hand the vent is very much higher. The absence of the vocal slits in the mouth suggest an absence of a vocal sac. Moreover the males show no nuptial asperities or sexual modifications of the base of the first finger. A vocal sac and vocal slits are likewise absent in *bromeliana* and presumably also in *taeniopus*. In these two latter species the head is broader than the body; in the present form the head is narrower than or equal to the width of the body. It agrees with *Hyla pinorum* in the absence of the tympanum but differs in length of legs, character of the snout, lesser amount of webbing on the feet, and smaller choanae.

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A New Subspecies of the Salamander *Desmognathus fuscus*

By Roger W. Barbour

During the past few years I have collected mammals, reptiles, and amphibians in eastern Kentucky, chiefly on Big Black Mountain, Harlan County. During the course of the study it has become apparent that the dusky salamander, *Desmognathus fuscus,* is represented in the area by an undescribed subspecies, for which I propose the name,

Desmognathus fuscus **welteri,**[1] subsp. nov.

Holotype.—United States National Museum No. 129312; adult male collected June 14, 1948, at an elevation of 2300 feet above sea level, at Looney Creek, near Lynch, Harlan County, Kentucky, by Roger W. Barbour.

Paratypes.—University of Louisville, Louisville, Kentucky, Nos. 3600–05; 6 specimens, collected June 7, 1948, from a spring at an elevation of 4000 feet above sea level, Big Black Mountain. Carnegie Museum, Nos. 29121–36; 16 specimens, collected June 13, 1948, from a spring run, elevation 4100 feet, Big Black Mountain. Chicago Natural History Museum, Nos. 61141–66; 26 specimens, collected July 9, 1948, from Razor Fork, elevation 3600 feet, Big Black Mountain. American Museum of Natural History, Nos. 54711–41; 31 specimens, collected July 9, 1948, from Razor Fork, elevation 3600 feet, Big Black Mountain. Cornell University, Nos. 5495–5508; 14 specimens, collected July 7, 1948, from the west fork of Looney Creek, elevation 2600 feet, Big Black Mountain. Personal collection of Roger W. Barbour, Nos. BM 1–23; 23 specimens collected June 6, 1948, from a spring run at an elevation of 4000 feet above sea level, Big Black Mountain. United States National Museum, Nos. 129313–54; 42 topotypes. All paratypes are from Harlan County and were collected by the author.

Diagnosis.—A well-marked population, differing from typical *fuscus* in the following particulars: size larger, adult males to 166 millimeters in total length, females slightly smaller; belly usually darker, with dark spots or irregular markings; usually without a median dorsal band, but with numerous brown to black irregular blotches.

Testes of adult males reticulated with brown to black pigment; in young males the pigmentation forms discrete stellate blotches; vomerine teeth in short series, varying from 5 to 10 in females, and from 3 to 6 in males; vomerine teeth usually lacking in adult males.

The population may be separated from *Desmognathus monticola,* which it superficially resembles, by a number of characters. In *monticola* the dorsal pattern consists of a series of paired or alternating light spots usually surrounded by darker areas; in *welteri* the dorsal pattern, though variable, usually consists of dark spots on a lighter ground color. Usually the belly of *monticola* is immaculate, that of *welteri* mottled. In *monticola,* the sides of

[1] This salamander is named in memory of my friend and former teacher, the late Dr. Wilfred A. Welter of Morehead State College, Morehead, Kentucky, who was a constant inspiration to many budding zoologists.

the head converge abruptly to the blunt snout; in *welteri* the sides of the head are more rounded.

DESCRIPTION OF HOLOTYPE.—Body length (snout to posterior end of vent), 74.5 mm.; total length, 138.5 mm.; head length, 16 mm.; head width, 13.5 mm.

Belly light, with numerous minute pigmented areas aggregated into small dark blotches. Back dark, with numerous unpigmented areas. Many irregular black blotches on back and sides, less abundant on tail.

VARIATION.—Like typical *fuscus*, this subspecies is quite variable, both in size and markings. Some exhibit a median dorsal band; the size, color, abundance, and distribution of pigmented areas is variable. A few specimens lack pigmented areas on the belly; some old males are quite dark dorsally, but darker blotches are nearly always visible. Females are generally smaller, slimmer, and tend to have a lighter belly than males.

Average measurements (in mm.) of 45 egg-bearing females are: body length, 61.3 (extremes, 50–70;) tail length, 54.7 (40–67). Twenty-five males average: body length, 70.2 (54–87.5); tail length, 60.8 (40–76).

RANGE.—Known from Bath, Carter, Elliot, Harlan, Menifee, Pulaski, and Warren counties, Kentucky, and Wise County, Virginia. Apparently this race reaches its maximum size on Big Black Mountain, Harlan County, Kentucky, and Wise County, Virginia. Specimens from Bath, Elliot, Menifee, and Warren counties, Kentucky, average somewhat smaller than specimens from the type locality and show intergradation with typical *fuscus*. Eighty-four specimens from Pulaski County, Kentucky, are only slightly smaller than specimens from the type locality.

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A New Snake of the Genus *Coniophanes* from Veracruz, Mexico

By James A. Peters

During a hurried visit to Veracruz preliminary to starting work in western Mexico, the Museum of Zoology Expedition to Mexico (1949) spent two days in the lowlands, collecting at several localities along the Puebla-Veracruz highway. The lowest of these localities (1000 feet) proved to be quite productive herpetologically, and among the material collected there is a single specimen of the genus *Coniophanes* belonging to a species which has not been described previously.

Coniophanes frangivirgatus, sp. nov.

Holotype.—University of Michigan Museum of Zoology, No. 101160; an adult female, collected ½ mile east of Plan del Rio, Veracruz, 1000 feet, 32 km. airline southeast of Jalapa on the Veracruz highway, which crosses a branch of the Rio Actópan at this point; by James A. Peters, March 7, 1949.

Diagnosis.—A *Coniophanes* of the *piceivittis* group; maximum dorsal scale rows 23; upper labials, 7, 3rd and 4th in contact with eye; lower labials, 9, 5 in contact with chin shields; a light spot on nape between the light stripe through eye and the dorsolateral light stripe.

Description of Holotype.—Dorsal scale rows 23-23-21-19, reducing by fusion of 9th and 10th scale rows opposite the 106th and 141st ventrals; ventrals, 165; subcaudals, 78 +n; upper labials, 7, 3rd and 4th in eye; lower labials, 9, 5 in contact with chin shields; preoculars, 2; postoculars, 2; temporals, 1-2 (6th labial on left side fused with the lower secondary temporal). Total length (382 mm., body + 140 mm., tail), 522 mm., tip of tail missing.

Head dark brown, vermiculated with light brown from the rostral to the level of the eyes; 2 minute paired light spots, one on each parietal. A light stripe from the top of the eye extends backward and is broken at the parietals for a space of 2 scales, after which it forms a spot 2 scales wide and 3 scales long. The stripe begins again on the neck after an interspace of 2 scales, and continues unbroken, about 1½ scale rows wide, almost to the tip of the tail. The black dorsal band is 5 and 2 half scale rows wide at midbody. The lateral black stripe is 3 and 2 half scale rows wide at midbody. All of the stripes are pronounced and sharply bordered, although the light area below the lateral dark stripe is suffused with darker color. The chin is heavily spotted, the throat is dotted with dark brown as far as the 10th ventral scute. The ventral surface is light yellow with widely scattered brown dots; each ventral scute is stippled with brown near the 1st scale row.

Maxillary teeth 8 or 9, increasing in length posteriorly, followed by a diastema and 2 enlarged grooved teeth.

Remarks.—*C. frangivirgatus* seems to be intermediate between the other two members of the *piceivittis* group. Although the lateral dark stripe in *frangivirgatus* is narrower than that of *piceivittis*, it resembles the latter in being much more sharply defined than that of *schmidti*. It has 23 scale rows, which is a common variant in *schmidti*. It differs from both *schmidti* and

piceivittis in possessing only 7 upper labials, 9 lower labials (occasional in *schmidti*), and in the presence of the light spot on the nape.

It seems likely that additional collections of this group will demonstrate a subspecific relationship between its members. Bailey (1937, Occ.Pap.Univ. Mich.Mus.Zool., 362:3) suggested that *schmidti* probably replaces *piceivittis* on the Yucatan Peninsula. He knew of no intergradation between them. *C. frangivirgatus* apparently represents the group on the east coast of Mexico north of the Isthmus of Tehuantepec, conforming thereby to a pattern of distribution already well illustrated in herpetology. *C. piceivittis* is the Pacific slope representative of the group. It is not known from north of the Isthmus.

The holotype was collected in a banana grove in one of the river valleys which dissect the low plains of Veracruz. These plains are exceedingly dry at this time of year, with pepper trees and cacti predominating in the flora. In the river valleys, however, an immediate change to arid tropical forest takes place, with a corresponding change in the fauna. The banana grove was irrigated with water from several springs at the base of the limestone walls of the valley, and was damp and humid. I also collected *Bolitoglossa platydactyla, Bufo cristatus, Engystomops pustulosus, Syrrhophus cystignathoides, Smilisca baudinii, Cnemidophorus guttatus guttatus, Sceloporus variabilis variabilis,* and *Coniophanes imperialis imperialis* in this banana grove. Only the *Cnemidophorus* and the *Sceloporus* were taken on the dry plain above the valley, where they were abundant.

Both the *Smilisca* and the *Bufo* were collected in a small breeding congress in a small pool caused by the blocking of an irrigation stream with debris. *Smilisca* was taken both while singing and in amplexus, and, although no eggs were seen in the pool, several masses were deposited in a collecting sack during the night.

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Two New South American Lizards

By Afranio do Amaral

THE well known genus *Gonatodes* was thought to be represented in Brazil by only two species (Amaral, 1937: 169), namely, ***humeralis*** Guichenot and ***spinulosus*** Amaral, both from the Amazon district. I have recently received a series of live specimens of a lizard found on the São Sebastião Island, near the north coast of the State of São Paulo, Brazil, which has proved on close examination to belong to a new species of that genus. All specimens were collected by Mrs. Helga Urban, in whose honor the new species is named.

Gonatodes ***helgae,*** sp. nov.

Holotype.—Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brazil, No. 2027; collected on São Sebastião Island, São Paulo, by Mrs. Helga Urban.

Paratypes.—Nos. 2028–38; from the same locality, by the same collector.

Diagnosis.—A small gecko, with digits slender, clawed and slightly depressed at the base; distal phalanges compressed, forming an angle with the basal portion of the digits, the lower surfaces of which are provided with only one row of enlarged plates. Body thick, rather depressed; dorsum covered with small granules intermixed with keeled tubercles forming regular longitudinal rows; tail cylindro-conical; pupil circular.

Description.—Head large, very distinct from neck; forehead convex; snout rounded and short, just as long as the oto-orbital distance; eye protruding; ear-opening small, oval; limbs slender, the posterior reaching the axilla; snout covered with suboval, rough granules; rostral twice as wide as high, with a median cleft above; nostril pierced between the rostral, 3 nasals and the first supralabial; supralabials 6, decreasing in size posteriorly; infralabials 5, also decreasing in size posteriorly; mental very large, triangular; infralabials separated from the gular granules by a row of scales decreasing in size posteriorly; dorsal keeled tubercles forming 12 to 14 longitudinal rows, extending to the tail base where they tend to change into half rings of rather enlarged, pointed, keeled scales; ventrals imbricate, cycloid to subhexagonal, changing anteriorly into granules under the neck, and posteriorly into a longitudinal series of transversely dilated scales under the tail; femoral pores not visible.

Dorsum dark brown, variegated with darker and lighter spots, the longitudinal rows of keeled tubercles all much lighter; tail with light black-edged cross-bands; labial sutures marked with white; lower surface dirty white and with brown cross-markings under the tail.

Living Habits.—Mrs. Helga Urban, a keen amateur zoologist, has been observing the living habits of this small, elusive lizard since 1948. This gecko is found on the ground, hiding under rocks or among piles of stones. It feeds both in daylight and at night, on all sorts of small arthropods such as crickets, beetles, moths, flies, ants and white ants. By mid-summer the

female lays a pair of eggs, each measuring up to 12 mm. in length by 9 mm. in width. The egg, which thus has a nearly spheroidal shape, is gray-white, profusely speckled with brown and black. Hatching occurs between April and May. Following the egg-shell cracking, about 2 hours are consumed in the eclosion process which always takes place right shoulder first, whereupon the young starts using its mouth to pull off and swallow the remaining strips of the enveloping membrane; eventually it may resort to rubbing its covering against the hard surface of a piece of wood or stone.

MEASUREMENTS (IN MM.)

No.	Total length	Head		Body length	Fore limb	Hind limb	Tail length	Remarks
		length	width					
2027	116	14	10	38	17	22	64	holotype
2028	90+n	14	10	44	17	23	regen.	
2029	97+n	14	10	44	17	23	regen.	
2030	118+n	16	11	42	17	24	inj. tip	
2031	106	13	9	36	15	21	57	
2032	101	13	9	35	15	21	53	
20[illegible]	114	14	10	36	17	22	64	
2[illegible]	86+n	14	10	36	17	22	regen.	
[illegible]	106	13	9	36	15	21	57	
[illegible]	86	11	8	30	14	19	45	
[illegible]37	76	10	7	26	12	17	40	juv.
2038	50	8	6	18	9	12	24	neo-nat.

Although the genus *Dracaena* Daudin has been considered monotypic up to the present, I have for some time suspected the existence in southwestern Brazil of a form quite distinct from *guianensis*. The northern form, found from the Guianas to the Amazon Valley and up to the Tocantins River to the São Francisco basin, corresponds to *guianensis* Daudin. It is particularly abundant in the tidal marshy sections (the "ygapós") of the Amazon district, where it seeks refuge in holes of fallen trees and feeds on snails. The other that is encountered in the Paraguay basin inhabits the "terra firme" surrounded by swamps (the "pantanal") particularly in southern Mato Grosso, Brazil, extending southwards to the Chaco district. It also feeds on snails, but, contrary to the behavior of *guianensis*, it usually seeks refuge in holes in dry ground or in termite nests. While the former is called respectively "Iguanuçu" (this name was misspelled "Ignarucu" by Daudin, following Valmont de Bomare) by the natives in the Guianas, and "Yacuruxi" by the Indians in the Amazon Valley (Brehm, 1913: 145; Testevin, 1922: 755), the latter is well known either as "Tuógu" among the Bororo Indians of Mato Grosso (Colbacchini and Albisetti, 1942: 439) or as "Bírgola" among the semi-civilized people of that district. As a matter of fact, the name "Bírgola" represents a corruption of "Bívora," the illiterate form of "Víbora," meaning "viper," since natives are always inclined to believe every lizard to be extremely venomous.

I am now able to confirm my suspicion, for at last a perfect specimen of the "Tuógu" has been captured alive and uninjured, and watched in captivity. I am indebted to Mr. E. Freundt both for his painstaking efforts to secure a series of photographs of this lizard and for his field observations thereon. His notes have been extremely useful to me in supplementing the description I have prepared, based on preserved specimens of the new form.

Dracaena paraguayensis, sp. nov.

HOLOTYPE.—Departamento de Zoologia, Faculdade de Filosofia, Univ. de São Paulo, Brazil, No. 696; collected in April, 1950, near the São Lourenço, a tributary of the Paraguay River, Mato Grosso, Brazil.

PARATYPES.—Instituto Butantan, Nos. 506–07, collected at Corumbá and No. 689 at Carandazal, Mato Grosso, Brazil.

DIAGNOSIS.—A large teiid, with tongue slightly widened but not emarginate posteriorly. Teeth acrodontoid: pre-maxillary 4, rather conical; lateral 5, very large, molar-like, with oval, flattened, crushing top, the 1st and 5th smaller; mandibular 10 (anterior 4, conical, smaller; posterior 6, flat, increasing in size posteriorly). A double gular fold. Head large, subpyramidal; nostril pierced in the suture between 2 nasals, on the canthus rostralis; ear exposed; upper, head shields more like those in *Crocodilurus lacertinus* (Daudin) than in *D. guianensis* Daudin.

DESCRIPTION.—Rostral large, subpentagonal; internasals forming a long suture; a large naso-frontal, hexagonal, much wider than long; a pair of large prefrontals, sometimes separated from each other by a small shield; a very large frontal, usually divided into 3 shields (2 anterior, subequal, or one much larger than the other; one posterior, sub-hexagonal, largest); a pair of fronto-parietals; an interparietal, rather small, and a pair of parietals, larger, sometimes subdivided; a pair of anterior occipitals and a pair of posterior occipitals, each pair sometimes divided into four shields; a row of 5 supra-oculars separated from the orbit by 2 rows of small scales; four large supra-temporals, a pre-orbital; 2 frenals followed by 2 or 3 rows of small freno-orbitals; a row of large infra-orbital scales; labials large, followed by a row of 5 or 6 smaller shields to the lip angle: supralabials 7 to 9, infralabials 7 to 10; an anterior, single chin-shield, followed by 8 or 9 pairs, all except the foremost separated from the infralabials by smaller shields enlarging posteriorly; gular and mesoptychial scales flat, sub-hexagonal. Dorsal scales small, irregular, intermixed with irregularly arranged, large, ovoid, strongly keeled tuberculoid scales. Abdominal scales small, narrow, feebly keeled, in 36 to 38 transverse, and 42 to 46 longitudinal series, each scale usually with a pit near the free edge. Pre-anal scales small, irregular. Limb scales small. Four to 6 pores on each side in front of the pre-anal region; 3 to 4 under each thigh. Caudal scales very narrow, feebly keeled, forming rings and with pointed free edge all around the tail; the dorsal tuberculoid scales gradually changing into a strong crest along each side of the upper surface of the tail.

Olive-brown above with interrupted lighter cross-bands changing into irregular spots on the flanks and tail sides; labial and chin-shield sutures

faintly marked with black; abdominal surface yellowish, marbled with grayish black.

MEASUREMENTS (IN MM.)

No.	Sex	Total length	Head		Body length	Fore limb	Hind limb	Tail length	Remarks
			length	width					
696	♀	685+n	76	43	195	93	130	414+n	tail tip miss.
506	♀	.....	63	38	150	75	112	.....	injured
507	♂?	.....	66	40	162	80	118	.....	injured
689	♂	675	73	42	178	90	124	424	

RELATIONSHIPS.—This new species is easily distinguishable from *guianensis* not only by the kind of scutellation, which in many points is more similar to that found in *Crocodilurus lacertinus*, but also by the higher number of rows of abdominal scales.

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Observations on the Spawning Habits of the Northern Pike, *Esox lucius*, in Northwestern Ohio

By Clarence F. Clark

THE location of large spawning runs of northern pike, *Esox lucius* Linnaeus, in streams tributary to Lake Erie, and the increased demand for predatory fish in Ohio's fisheries program, have awakened an interest in this species in Ohio. The pike was known in northwestern Ohio prior to 1900 and was present in great numbers, according to older residents. Many were taken in those days by means of spears, seines and pitch forks. Throughout this area their presence, only during the spawning runs, resulted in a lack of interest in the fish on the part of present-day sport fishermen.

In the spring of 1949, 229 northern pike were netted from tributaries of Lake Erie and placed in a 5.33-acre pond at the St. Marys State Fish Farm. Also, 821 breeder pike from these streams were stocked in Nettle Lake, Williams County, Ohio, during the 3 years 1947–1949. Observations on spawning were made at the hatchery pond, at Nettle Lake, and at several streams in northwestern Ohio. Data on the incubation of eggs were obtained from eggs held in aquaria, in bell jars at the hatchery at the Toledo Zoo Aquarium, and in special screen hatchery troughs suspended in the above-mentioned hatchery pond.

Observations on the spawning runs of northern pike and on actual spawning seem to indicate that the object of the migration is to find marsh-like conditions for spawning. In Nettle Lake, and in East Harbor which is a bay of Lake Erie, northern pike spawned in marsh-like areas within the lakes even though tributary streams were readily accessible. No migration was noted in Nettle Lake except into and out of the marshes. Nine spawning groups were observed in the act of spawning in a marsh at Nettle Lake within 75 feet of the mouth of a tributary stream. Spawning runs up numerous streams of northwestern Ohio are observed every spring, many of them by Mr. Harold Wascko, Curator of the Toledo Zoo Aquarium. The facts obtained indicate that the chief factor in the control of this migration is the ice cover on the stream riffles. The open winter of 1948–1949 permitted free passage of the adults throughout the streams, and breeders were observed in early February in small tributaries of Lake Erie. No ditches seemed too small for the pike, provided that some vegetation or debris, with enough water to partially cover the breeders, was present. Males predominated in the early upstream movements, as shown by test nets, and females were more prevalent in the latter part of the run. Carbine (1942) found a similar difference in the migration dates for the sexes. Net catches on spawning runs indicated that the greatest movement of breeders occurred at night.

All spawning groups were observed to spawn at a depth of 20 inches or less, with a majority of the spawning taking place in less than 10 inches of water—as compared to 6 to 18 inches found by Williamson (1942). Many large females were observed to spawn with their backs out of water. In most instances where spawning was seen, the water was clear and the eggs could

easily be located. However, spawning was observed in one section of Nettle Lake with a Secchi disc reading of 2 inches. Such low transparencies probably do not affect the spawning act. The waters in which spawning occurred varied in appearance from a light brown in bog-like bays to the heavily silt-laden flood waters along lesser protected shores. The pH of waters on the spawning grounds varied from 6.8 to 8.2; both figures were obtained at Nettle Lake.

The type of bottom over which spawning occurred varied greatly, but a soft silt filled with decaying vegetation predominated. Observations indicate that soft silt and decaying vegetation are not the primary objects of preference but are associated with them. Spawning occurred in the hatchery pond over coarse, stone rip-rap when large amounts of cat-tail debris and quiet water were present. Schindler (1946) reported that northern pike in Europe spawn in shallow waters of rivers and lakes and in inundated meadows and swamps.

The number of breeders in a spawning group varied from 1 male and 1 female to 3 males and 1 female. Random counts of 59 spawning groups at several localities revealed 24 groups composed of 3 males and 1 female, 22 of 2 males and 1 female, and 13 of 1 male and 1 female. Whenever the group was composed of 1 male and 1 female, the breeders were almost equally matched in size and were approximately 20 inches or more in length. In most spawning groups of 3 males to 1 female, the males were smaller and averaged approximately 15 inches in length.

The following spawning behavior was typical. The group moved along slowly, paused frequently to complete the spawning act, then moved on, and the process was continued until the group encountered some obstacle or was frightened. The female was generally slightly in advance of her mates; but oftentimes the males swam adjacent to her. On several occasions, one individual in a group of 3 males was observed swimming directly over the female. Just prior to the spawning, the group slackened its speed, and each male moved into position with its urogenital opening on about the same line as that of the female. Then the spawning act was completed with a splash. Each male curved the caudal portion of its body outward and brought it against the female with a slap. All would then dart forward from the spawning site. The eggs could be found as soon as the water cleared after the splash. The splashes from many of these spawning acts could be heard from distances up to 200 feet. The general effect was like that caused by spawning carp; similar observations were reported from Wisconsin by Williamson (1942).

Observations on several groups of spawning pike indicate that spawning took place every 3 to 5 minutes in unmolested groups. One group of 3 males and 1 female was observed to spawn on an average of every 5 minutes for nearly 2 hours. One female, with a peculiar scar on her head, was seen spawning on 3 consecutive days at Nettle Lake, accompanied by 3 small males.

Although observations were made during several nights, no spawning splashes were heard and no spawning fish were seen with the use of power lights. Spawning groups were observed as early as 6 A.M. and as late as 6:30 P.M. Ripples on the hatchery pond at St. Marys, and cloudy days, seemed to reduce the spawning activities. Cool nights also seemed to delay spawning

activities the following morning. For example, the night of April 1, 1949, was cold at Nettle Lake. Spawning was observed at 5:30 P.M. but no spawning activity was observed until 11:50 A.M. on April 2. The morning of April 2 was cloudy and the water temperature in the inundated swamp was 6 degrees lower than that of the evening before. When the sky cleared and the water temperature raised to 48° F., spawning began. The water was extremely clear in the marsh and the bottom could be seen throughout the small area. The pike were first observed at the edge of the marsh near the open lake and their movements back into the marsh were easily followed. Two spawning groups were followed from the edge of the open water through the marsh to the shallowest water where most of their spawning took place. All spawning groups observed in the marsh on April 2 started to spawn near the open lake and gradually worked back into the more shallow waters of the area.

Northern pike were observed to work up the tributary streams of Lake Erie when the water temperature was 32° F. and ice covered the pools. They were found in some of the shallowest tributaries in early February, but no spawning activities were noted until the water temperatures reached 48° F. McKay (1931) reported spawning temperatures for muskellunge from 49 to 58° F. The period of active spawning in the St. Marys hatchery pond lasted from March 28 to April 3. No spawning was noted before or after these dates. On April 8, 1949, eggs ran freely from 3 large females taken in nets in Russia Creek, Ottawa County. The water temperature in this stream was 48° F. on that date.

According to Williamson (1942) the eggs, when deposited, sink to the bottom and are not adhesive. Eggs in the hatchery pond and at Nettle Lake were found attached to floating debris and vegetation or were scattered over the bottom. Like carp eggs, they were found wherever they settled after being scattered by the spawning splash. Some eggs remained attached to stems when removed from the water; others rolled along the stem as if held by the surface tension of the water; and still others dropped off as the debris was removed from the water. The detached eggs settled slowly to the bottom, revealing a density only slightly greater than that of the water. The eggs, shortly after being deposited, averaged 2.3 mm. in diameter and were tan in color.

Eggs were obtained at sites where spawning had just been observed. These eggs were transferred, some to aquaria and others to hatching trays in hatchery ponds. They hatched during a period of 7 to 10 days at an average water temperature of 52° F. Mr. Harold Wascko found that eggs, obtained and fertilized by stripping, hatched in 7 to 10 days at a temperature of 52° F. in bell jars at the Toledo Zoo Aquarium.

The author is extremely grateful to Mr. Harold Wascko, Curator of the Toledo Zoo Aquarium, for information which he supplied; and to Mr. E. L. Wickliff, Chief, and Mr. Lee S. Roach, Assistant Chief, of the Fisheries Section of the Ohio Division of Wildlife for their advice.

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DIVISION OF WILDLIFE, STATE FISH FARM, ST. MARYS, OHIO.

A New Genus of Poeciliid Fishes from Hispaniola, with Notes on Genera Allied to *Poecilia* and *Mollienesia* [1]

By LUIS RENÉ RIVAS and GEORGE S. MYERS

IN a recent paper on cyprinodont fishes of the Island of Hispaniola, Trewavas (1948) described a new species of poeciliid fish which she assigned to the genus *Mollienesia* (*elegans*) on the basis of gonopodial characters. The material upon which this and other species in the same paper were based came from a German aquarist, Mr. E. Roloff, who also had sent a series of the same collection to one of us (Myers). We had studied an adult male and female of this species before Dr. Trewavas published on it, had determined that it was new, and had come to certain conclusions about its generic position.

During the month of April, 1949, one of us (Rivas) had the opportunity to spend several days in the Dominican Republic collecting freshwater fishes, especially poeciliids, and the type locality of *M. elegans* was visited. Study of a fine series of topotypes shows that this species constitutes a remarkable new genus of the tribe Poeciliini that is apparently confined to the Island of Hispaniola.

Parenthetically, it should be pointed out that the new *Rivulus* (*R. roloffi*) described by Trewavas was in fact named, figured, and described by Roloff ten years earlier (1938: 597). He credited the name *Rivulus roloffi* to "Trewavas, 1938" but since no previous description had been published, and Trewavas evidently took no part in the preparation of Roloff's paper, it would seem that Roloff must be responsible for (in the words of the International Rules) "the name and its indication, definition or description." Roloff gave a

[1] Results of the University of Miami—University of Santo Domingo Ichthyological Expedition to the Dominican Republic, April, 1949.

good color description, photos of both male and female, and a type locality (Villa Altagracia). These seem sufficient to distinguish the species from its close relatives.

We are very grateful to Drs. Carlos Conzález and Burton P. Hunt, of the Universities of Santo Domingo and Miami, respectively, for their valuable assistance during field work in the Dominican Republic.

Curtipenis, gen. nov.

GENOTYPE.—*Mollienesia elegans* Trewavas (1948: 409).[2]

In *Curtipenis,* the gonopodium (Trewavas, 1948, Fig. 2) is of the *Mollienesia* type. The membranous hook at tip of ray 3 is obsolescent as in *Mollienesia* (*Allopoecilia*) *caucana* and in certain subspecies of *M. sphenops* (*cuneata, vandepolli*). The elongate, retrorse, terminal segment of the posterior branch of ray 5 is present and well developed, as in *M. latipinna, M. velifera, M. petenensis,* and *M.* (*Psychropoecilia*) *dominicensis.* The subterminal segment of ray 3 and posterior branch of ray 4 bear retrorse spines as in the other species of *Mollienesia,* with the exception of *dominicensis,* in which the spines of ray 3 are broadly T-shaped and somewhat bifurcate.

The most distinctive feature of the gonopodium of *Curtipenis* is the structure of the membranous swelling of the anterior margin of ray 3, which is not modified into a movable prepuce-like hood as in the other genera of the tribe Poeciliini. In this character, the gonopodium of *Curtipenis* resembles that of *Platypoecilus* and *Xiphophorus* to which *Curtipenis* is not closely related, since it is obviously a member of the tribe Poeciliini. Consequently the statement, "Membranous swelling on front of gonopodium not forming a definite prepuce-like hood," in Hubbs' diagnosis of the tribe Xiphophorini (1924: 10), can no longer be used as a diagnostic character for that group. Likewise, the diagnosis of the tribe Poeciliini, as proposed by Hubbs (1924: 11; 1926: 72) should be modified by adding parenthetically, "(except in *Curtipenis*)" to the statement, "Membranous swelling along anterior margin of gonopodium modified into a prepuce-like hood." If this modification is adopted, the diagnosis for the tribe Xiphophorini need not be changed.

There is a shallow, longitudinal recess or groove along the midline of the belly where the gonopodium is partially concealed when depressed against the body in swimming.

The pelvic fins of the male are typical of the tribe Poeciliini. The first ray is much shorter than the elongate second ray, and its tip is membranous and swollen. The inner rays are abruptly shorter than the second ray but longer than the first, especially the third.

The maxillary is partially overlapped by the preorbital, which has its lower border slightly raised but not free. The preorbital area is scaleless.

The jaws are strong and firmly united, and the upper is somewhat shorter than the lower. In front view the upper lip is arched and broad enough to

[2] The basis for the spelling *Mollienesia* (rather than *Mollienisia*) is presented by Bailey and Miller in this issue of COPEIA.

be distinctly visible (Fig. 1B). The teeth of the outer row (Fig. 1) in both jaws are movable, narrowly and acutely spear-shaped, elliptical in cross-section, and with brownish tips curved inwards. They are arranged uniserially in a single arc, rather widely spaced, and never in contact with each other. The teeth of the inner row (Fig. 1), similar in shape to those of the outer, are much smaller and arranged biserially, those of the innermost series somewhat displaced in alternating pattern. In the lower jaw the inner row is about as long as the outer, but in the upper, it is longer and extends back-

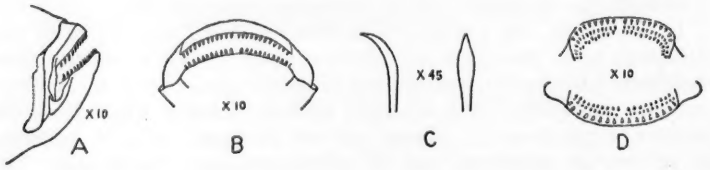

Fig. 1. Mouth structure and dentition of *Curtipenis elegans*. A. Mouth in side view. B. Mouth in front view. C. Tooth of outer row in side and front views. D. Upper and lower jaws showing arrangement of teeth. Semidiagrammatic drawings by L. R. Rivas, based on an adult female 44.6 mm. in standard length.

wards for a distance at each end. In both jaws, the inner row is interrupted at the symphysis by an edentulous midsection.

That the new genus is a member of the subfamily Poeciliinae and the tribe Poeciliini is indicated by the structure of the gonopodium and of the pelvic fins. However, in working out the relationships of *C. elegans*, it has become apparent that complete reliance cannot be placed on gonopodial structure alone in the definition of genera within the Poeciliini. A similar conclusion was reached in the Cuban tribe Girardinini, in which the chief generic characters are centered in the structure of the jaws and teeth (Howell-Rivero and Rivas, 1944). The gonopodium has proven to be so useful in classification that great attention has been paid to it, but it seems to us that the minor quantitative structures of this organ have been overemphasized in generic segregation in the entire family. As knowledge increased, intermediate types were found, lessening many of the apparently sharp gonopodial differences based on these minor characteristics. We conclude that these finer gonopodial differences should not be accorded more than specific value unless they are clearly correlated with other structural differences, leaving the major qualitative characters of the gonopodium (such as those used by Hubbs (1924) to separate subfamilies and tribes) as general indications of major phylogenetic lines. It is, indeed, in these major gonopodial features that we find definite correlations between gonopodial and other structural characters, and this correlation strongly supports the conclusion that the microscopic structure of the gonopodium is, if used with circumspection, one of the most useful indicators of both relationships and divergence known among poeciliid fishes.

Curtipenis elegans (Trewavas). Adult male (top) and female topotypes, 33 mm. and 47.3 mm. in standard length, respectively. (Photographs from the Smithsonian Institution; retouched by L. R. Rivas.)

Although the gonopodial structure indicates relationship to *Mollienesia,* the mouth structure, dentition and basic features of coloration are very different from that genus. There is no other member of the tribe Poeciliini to which *Curtipenis* shows close relationship. It seems possible that this genus represents a survival of the ancestral stock of the *Mollienesia* group, which has retained more primitive jaw and tooth characters than the other existing forms. But whether the absence of a definite prepuce-like hood is primitive or specialized is difficult to decide. If, as we believe, this is a primitive characteristic, then *Curtipenis* may be considered the most primitive member of the tribe Poeciliini.

On this basis, it would appear reasonable to assume that *Curtipenis* or its ancestor colonized Hispaniola at a time when fishes of this type existed in Central America. Later, its relatives evolved into more specialized forms or became extinct, leaving *elegans* a relict preserved by geological and ecological accident, and perhaps also by its rheophilic nature and differing feeding habits.

Since the original and only available description of *Curtipenis elegans* was based on only two specimens, a more detailed description of the topotypic material recently collected is hereby offered.

Curtipenis: In reference to the very short gonopodium.

Curtipenis elegans (Trewavas)

Plate I

Mollienisia elegans Trewavas, 1948: 409 (original description, Jarabacoa, Dominican Republic), Fig. 2 (gonopodium), Pl. 1, Fig. 4 (photograph: male and female).

The following description is based on 5 adult males 28.4 to 33 mm. in standard length, and 19 young to adult females 15.1 to 47.3 mm. long, from a series of 53 topotypes collected in Rio Yaque del Norte at Jarabacoa (about 1700 feet above sea level), Province of La Vega, Dominican Republic, by Luis René Rivas and Burton P. Hunt on April 24, 1949. This material is deposited in the fish collections of the University of Miami, Department of Zoology. Specimens have also been deposited in the U. S. National Museum, the Museum of Zoology of the University of Michigan, and the Natural History Museum of Stanford University.

Proportions are expressed in hundredths of the standard length. Proportions and counts for the males are given first, followed by those of the females in parentheses. For the methods of measuring and counting used herein, see Rivas (1944: 41). All measurements and counts were made under the low power of a binocular microscope.

Body compressed, more strongly in males and posteriorly in females, the axis straight. Predorsal contour uniformly convex between tip of snout and occiput, more or less straight, or even somewhat concave, between occiput and origin of dorsal fin in the larger females; transversely convex in both sexes, the head not depressed.

Predorsal length 55.01 to 56.20 (58.30 to 61.60); postdorsal length 46.35 to 47.15 (41.22 to 43.55); preanal length 44.85 to 46.65 (54.90 to 64.10); postanal length 58.15 to 60.30 (41.00 to 45.05). Length of caudal peduncle 52.40 to 53.30 (31.49 to 34.30); its least depth 17.54 to 18.18

(14.57 to 16.92). Greatest depth of body 25.60 to 27.28 (23.18 to 28.64). A study of the original data on which these proportions are based, shows that neither the predorsal nor the postdorsal comparative lengths vary with age, and that therefore the dorsal fin remains constant in relative position throughout development. In the females, the preanal length increases somewhat with age with a corresponding decrease in the postanal length. This apparent posterior migration of the anal fin is actually an outward displacement, with the base of the last anal ray as pivoting point, caused by gradual distention of the abdomen in reaching maturity, as shown by the increase of body depth with age. This is further confirmed by the fact that the comparative length of the caudal peduncle does not vary with age. The caudal peduncle shows no increase in depth with age.

Head length 25.43 to 26.06 (24.12 to 29.40); its greatest width 16.02 to 16.68 (18.11 to 20.00), somewhat less than least depth of caudal peduncle in males, greater in females. There is a relative decrease with age in head length and a very slight decrease with age in head width. Overall width of mouth 10.00 to 10.58 (10.30 to 12.61), decreasing with age. Least fleshy interorbital width 11.22 to 12.11 (12.90 to 15.24), decreasing with age, greater than overall width of mouth. Postorbital length 8.78 to 9.70 (9.15 to 11.95), decreasing with age, less than overall width of mouth. Diameter of orbit 9.08 to 9.30 (7.41 to 11.92), decreasing with age, about equal to postorbital in males and young females up to about 20 mm. in standard length, somewhat less in subadult and adult females; less than interorbital and overall width of mouth. Snout 8.08 to 8.79 (8.00 to 9.93), less than postorbital.

Dorsal base 15.49 to 16.50 (14.12 to 15.41), not varying in length with age, about equal to greatest width of head in males, much less in females. Anal base 9.25 to 13.24 in females, decreasing in length with age, shorter than dorsal base. Dorsal fin convex in outline, rounded posteriorly at the tips of the last rays, much longer than high; its length 28.77 to 29.78 (23.18 to 27.20), not varying with age, greater than head in males, about equal to or less than head in females. Gonopodium 22.73 to 23.64, shorter than head, reaching somewhat beyond a vertical from middle of dorsal base, but not to its end; distance between distal end of membranous swelling on ray 3 and tip of gonopodium about equal to diameter of pupil. The structure of the gonopodium has been discussed under the generic description. Anal fin of females smaller than the dorsal, longer than high, triangular in outline, rounded at the apex and posteriorly at the tips of the last rays, its length 18.80 to 22.46, decreasing with age, its posteriormost tip not reaching to a vertical from posteriormost tip of dorsal. Pectoral fin broadly rounded, asymmetrical, the upper rays longer than the lower, its length 21.40 to 22.42 (19.45 to 24.12), decreasing with age in females, about equal to or somewhat longer than anal in females; its posteriormost tip reaching to or beyond vertical from insertion of pelvics in females, beyond origin of gonopodium in males; its base less than diameter of orbit but much greater than diameter of pupil. Pelvic fin 20.60 to 21.81 (14.04 to 16.34), reaching beyond middle of gonopodium in males, to or beyond anus in females, and to origin of anal in young females up to about 30 mm. in standard length. Pelvic fin of females rounded at tip,

asymmetrical, the inner rays gradually decreasing in size. The structure of the pelvic fin of males has been discussed above, under the genus. Caudal fin broader than long, its greatest width when fully spread about equal to or greater than head or depth of body, its posterior margin uniformly convex (especially in females), the upper and lower posterior angles rounded; middle caudal rays 26.92 to 28.86 (24.12 to 30.10), decreasing in length with age, about equal to head.

Origin of dorsal fin about midway between middle of caudal base and center of eye in males; midway between middle of caudal base and a point on postorbital area (at level of upper end of pectoral base) in females; closer to eye in young or to posterior border of opercle in adults. Origin of gonopodium somewhat nearer tip of mandible than posterior tip of dorsal fin. Origin of anal fin of females nearer caudal base than center of eye; in advance of origin of dorsal in young up to about 35 mm. long, below or somewhat behind in adults (see discussion above). Upper end of pectoral base nearer tip of snout than origin of dorsal in males and females. Insertion of pelvic fin about midway between tip of gonopodium and center of eye in males; nearer upper end of pectoral base than end of anal base in females.

Dorsal rays 8 to 10, usually 9; anal 9; pectoral 14 to 16, usually 15; pelvic 6; branched caudal rays 14 to 16. Scales in 28 or 29 (usually 28) transverse rows.

Basic coloration (in 10 per cent formalin) light pearl gray, tinged with brownish yellow in some of the larger females. A conspicuous midlateral longitudinal dusky band, about as wide as diameter of pupil, on sides of body, originating at middle of caudal base and breaking up into dark brown, elongate, vertical dots below origin of dorsal fin. Below this band, there is a longitudinal row of dark brown spots gradually decreasing in size towards the tail and disappearing behind the end of the anal base in females and the tip of the gonopodium in males. These spots are similar to but smaller than those forming the anterior portion of the main lateral band with which they alternate. The spots of each row are connected by dusky lines along the scale-pocket margins, forming a zig-zag pattern; both rows converge forward and unite at the axil. There are two longitudinal rows of brown spots above the lateral band, gradually becoming fainter posteriorly and disappearing behind end of dorsal base. Preorbital area and top of head dusky, especially on the interorbital and occipital regions. A middorsal dusky streak, extending from the dark occipital area to origin of dorsal fin, gradually becoming wider at a distance about equal to postorbital from dorsal origin. A very fine, somewhat faint, black line along the lower edge of the caudal peduncle. Scale pockets margined with brown, producing a reticulate pattern fainter posteriorly and undeveloped on the lower portions of the body below the lateral band complex. A sharply defined, oblong, dark brown spot on pectoral base. Belly colorless. Caudal fin with a vertical row of black, horizontally elongate spots (on rays), about midway between base and margin of fin; a similar but less conspicuous row is present on either side of the main one, especially in the larger females. Dorsal fin with a broad, but faint, dusky margin distally, crossed by a row of black spots (on membranes) not extending forward to anterior margin of fin. Anal, pectoral and pelvic fins colorless. Gonopodium

colorless. There is no apparent sexual dimorphism in the coloration.

In addition to those from Jarabacoa, numerous examples of *Curtipenis elegans* were obtained in the Río Camú, of the Yuna system, at a point on the road from Jarabacoa to La Vega, about 5 km. west of La Vega.

Although seemingly confined to a highland habitat, the temperature tolerance of this species appears to be rather great. At Jarabacoa, the water temperature during collecting time (9–10 A.M.) was 68° F., whereas later in the day (1–2 P.M.), in Río Camú, the water was 80° F. It is doubtful, however, if the species can live in much warmer waters. On the other hand, there is reason to believe that *C. elegans* occurs on the Yaque del Norte, well above Jarabacoa, where the water, especially during the winter, reaches temperatures much lower than 68° F.

While collecting at Jarabacoa, it was learned that *C. elegans* apparently avoids very fast water by staying close to the banks of the stream; it was most abundant in places where the banks were overgrown with thick aquatic vegetation. In general, however, the waters where the species was obtained were fast and clear.

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University of Miami, Coral Gables, Florida, and Natural History Museum, Stanford University, California.

Some Interesting Cells in the Blood of a Diseased Silver Salmon Fingerling [1]

By Max Katz

ALTHOUGH examination of the blood is routine in the practice of human medicine, fisheries pathologists have, with a few exceptions, completely overlooked the important changes that take place in the blood picture of diseased fish. Red cell counts have been used to evaluate hatchery diets, and Field, *et al* (1943, 1944) have made a most complete analysis of the blood constituents of normal and diseased carp and trout. Yet, aside from the brief observations of Barbudieri (1930) and Plehn (1924), no others have reported the interesting blood cells produced by the reaction of fish to some diseases.

During the period in which the role of the blood in combating disease was first intensively studied, several workers used fish as experimental subjects in their studies of the immunity mechanisms. Mesnil (1895) injected anthrax bacilli intraperitoneally into *Perca fluviotilis, Gobio fluviatilis* and *Carassius auratus*. These bacteria were ingested and destroyed by numerous mononuclear leucocytes. Mechnikov (1905) found that erythrocytes of guinea pigs injected into goldfish were immediately ingested by phagocytes. Cuenot (1907) injected India ink into several species of fish and found that the fine ink particles were ingested by nephrophagocytic cells located in the heart and kidney. It must be noted, however, that these observations were made upon healthy fish that were responding to the introduction of foreign matter.

Macrophage cells (or histiocytes, clasmatocytes) are known to have a function in healthy fish. Agnessoti (1932), in an admirable study of the hematology of fingerling rainbow trout, described macrophage leucocytes which were seen ingesting and presumably destroying effete erythrocytes. Yokoyama (1947) found macrophage cells in the spleen and kidney of *Perca flavescens*, where they were seen destroying effete erythrocytes. Nothing had yet been observed of the function of the macrophage cells in the blood of fish infected by the usual fish pathogens.

In this note, I am reporting what is believed to be the first account of the defensive action of fish macrophages against fish pathogens. This observation of the defensive action of the silver salmon's leucocytes against pathogens was due to accident. Some wild fingerling silver salmon, *Oncorhynchus kisutch* (Walbaum), were collected in Swamp Creek, near Seattle, Washington. These fish, which were about 60 mm. in fork length, were placed in a hatchery trough in the pathology laboratory at the School of Fisheries, University of Washington. After some of the fish had been sacrificed to satisfy requirements of another project, the remainder were kept in the troughs and were sadly neglected for about two weeks. Upon return, it was found that most of the fingerlings had died of a disease resembling

[1] This study was aided by a grant from the Research Grants and Fellowships Division of the U.S. Public Health Service, Bethesda, Maryland, and was made at the School of Fisheries, University of Washington, Seattle.

the ulcer disease described by Fish (1934). Smears of peripheral blood taken from a diseased survivor showed several unusual blood cells.

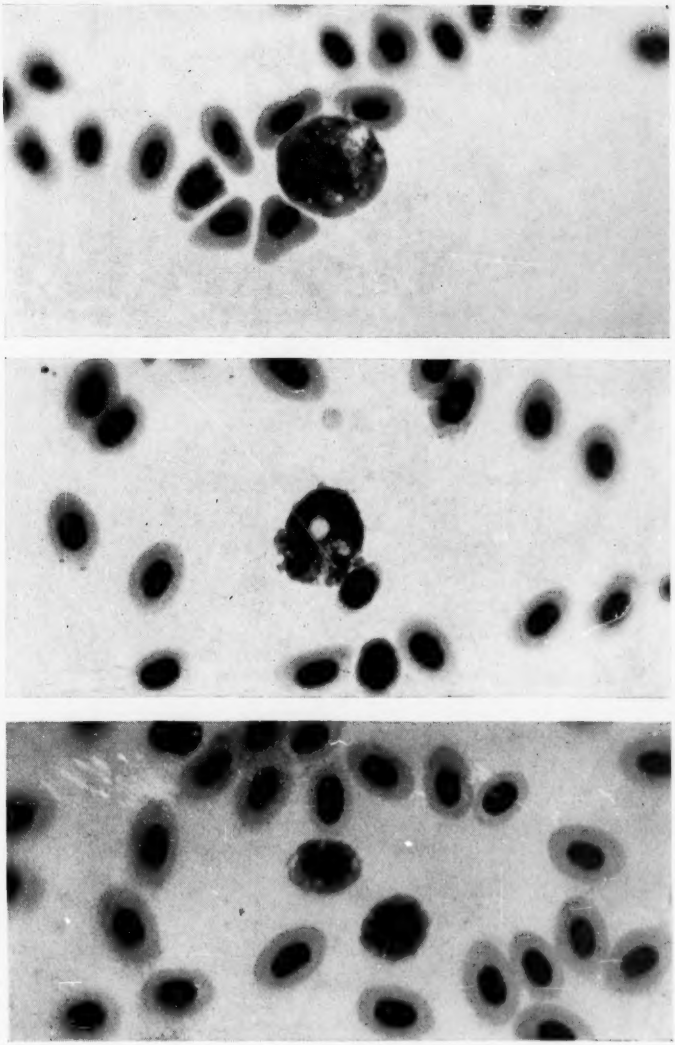
The Giemsa-stained blood smears showed macrophage leucocytes (Plate I, upper and middle) that had been fixed in the process of phagocytosis. These bacteria-ingesting macrophages were large, irregular cells that were varible in size and form. Twenty-five cells that were measured ranged from 10 to 22 microns along their longer axes with most of the cells about 13 to 21 microns. Their shorter diameters ranged from 8 to 15 microns. The cells contained a single, roughly circular or oval, basophilic nucleus which was frequently indented by the adjacent cytoplasmic vacuoles. The macrophages contained from one to seven vacuoles as cytoplasmic inclusions. Most of the cells, however, had only one or two vacuoles. These vacuoles, which were from 1 to 4 microns in diameter, contained the ingested bacteria. One macrophage was observed ingesting an immature erythrocyte. The nucleus of the macrophages was basophilic and was often vacuolated. The abundant cytoplasm of the macrophages was basophilic and contained the characteristic bacteria-filled vacuoles. These macrophage cells were very irregular in outline because of the extrusion of many pseudopods of pale blue cytoplasm.

The origin of the macrophage cells is unknown. A thorough study of the hemopoietic tissues of the diseased fish would be necessary to determine their origin with certainty. It is supposed, however, that the macrophages are specialized monocytes. No observations by the author can substantiate this hypothesis, but Lewis and Lewis (1935), while studying the living blood cells of several teleosts by the hanging-drop method, demonstrated that mononuclear leucocytes could transform into macrophages.

Although the normal leucocytes of the blood, the lymphocytes, neutrophiles, and monocytes, were in evidence on the slide, only these mononuclear macrophage cells contained any ingested bacteria.

Not only were macrophage leucocytes noted in the blood smears of this diseased fish but some anomalous erythrocytes (Plate I, lower) were also seen. Because of their rounded shape, basophilic cytoplasm, and the lack of condensed basichromatin material in their nuclei, these cells resemble in some respects the immature basophilic normoblasts of healthy fish. Immature erythrocytes, especially basophilic normoblasts, are, however, rare in the blood of fingerling silver salmon. In addition to this unusual abundance, these cells differ morphologically from the other normal erythrocytes. These immature red cells are about the same length as the mature erythrocytes among which they lie, but seem larger because of their greater width. These cells are rounded or only slightly elliptical. They ranged from 10 to 15 microns in their longer axis and from 5 to 11 microns in their shorter axis. The mean dimensions of 26 of these cells was 12.1 microns by 8.9 microns. The nuclei of these basophilic cells were from 7 to 10 microns in their longer axis and from 4 to 9 microns in their lesser axis. The nuclei of 26 cells averaged 8.9 by 6.4 microns.

The cytoplasm of these pathological erythrocytes was not so blue as that of the lymphocytes with which they might be confused and was, in addition, somewhat vacuolated. The nuclei of these cells were relatively larger than nuclei of the normal erythrocytes, and were somewhat elliptical.



Upper.—Macrophage leucocyte in the blood of diseased fingerling silver salmon (× 784). Note ingested bacteria in cytoplasmic vacuole.

Middle.—Macrophage leucocyte (× 784). Note bacteria in vacuoles, pseudopodia and vacuole in nucleus.

Lower.—Immature erythrocytes in blood of diseased silver salmon (× 784). Note basophilic cytoplasm and the irregular outlines of the nucleus and cell wall.

The nucleus stained typically and contained a rather diffuse chromatin. In some of these cells the nuclear material was condensed, in only a few spots, sufficiently to show the typical basichromatin of the normal nucleus. The nucleus was often vacuolated, adding to its rather patchy appearance. A well defined nuclear membrane was lacking. In fact, the entire cell was somewhat ragged in appearance as compared with the neat contours of the other red cells.

These peculiar basophilic erythrocytes, as well as the bacteria-ingesting macrophages, are definitely a pathological manifestation. Barbudieri (1930) had noticed similar erythrocytes in the blood of several fish that were infected with blood flagellates, but he was not completely convinced that these cells were of pathological significance for he had seen somewhat similar cells in apparently healthy fish. It does seem to me that the blood picture observed in the smears of these fingerling salmon is of a definitely diagnostic character and is indicative of a bacterial disease. Although many other young and adult silver salmon had been previously examined that had been infected with blood flagellates, myxosporidia, haemosporidia, and the usual variety of helminths, none had this striking blood picture (Katz, 1949).

The use of stained blood films is believed to be a valuable aid in the diagnosis of fish diseases and could be applied with little trouble to hatchery problems by the pathologist. Diseases of fish could be more clearly defined if the characteristic blood picture produced was reported along with the descriptions of the lesions and bacteriological findings.

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[2] An important paper by Pliszka (1939) was recently called to my attention. While studying the immunological reactions of carp to *Pseudomonas punctata,* phagocytic leucocytes similar to those described above were observed in blood and in purulent matter from skin and muscular abscesses.

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Correlation Between Temperature of Water and Size of Marine Fishes on the Atlantic and Gulf Coasts of the United States [1]

By GORDON GUNTER

ABOUT seventy years ago Karl Möbius noted that several species of invertebrates from the Arctic seas near Greenland grew to larger size than they did in the Baltic Sea (Semper, 1881: 132). It is now well recognized that animals in polar seas grow to larger size than the same species in temperate or tropical seas. One of the most recent statements is that of Mann (1948), who reported "giant size of invertebrates" as one of the characteristics of Antarctic life. Many naturalists have noted the phenomenon. Several references may be found in the general texts by Murray and Hjort (1912: 612), Hesse, Allee and Schmidt (1937: 159), and Sverdrup, Johnson and Fleming (1946). Kofoid (1930) and others have shown that certain protozoans and other organisms in cold currents grow larger than those in warmer waters nearby. Tropical copepods are smaller than polar species (Sverdrup, *et al., op. cit.*). Warming (1909) has noted that in colder seas the brown algae are larger. The same law holds for most marine organisms. Probably Weymouth and his colleagues have given the most precise data on this subject. In a study of the growth of the Pacific cockle (*Cardium corbis*

[1] Contribution No. 476 of the Scripps Institution of Oceanography of the University of California.

Martyn), Weymouth and Thompson (1931) showed that the northern forms, in contrast to the southern, have a slower initial but more sustained growth, and reach greater age and larger size. Weymouth, McMillin and Rich (1931) showed that in the razor clam (*Siliqua patula*), growth in southern localities as compared with the northern is initially more rapid but less sustained, leads to smaller size, and is associated with shorter life span.

It is also known that northern species are larger on the whole than more southerly species of the same genus. The directions are of course reversed in the southern hemisphere. Wimpenny (1941) reviewed much of the literature on this subject and discussed some of the exceptions to the general rule.

Delayed sexual maturity, longer life, slower growth and greater final size are characteristics of animals in colder seas. The phenomenon seems to be dependent upon progressive retardation of growth by lowering temperatures poleward. It is well known that sexual maturity and growth are hastened by high temperatures, but that certain growth inhibitors operate at the time of sexual maturity to slow or stop growth. Therefore, the faster the growth, the less the final size. There is also a direct correspondence between the rate and final degree of differentiation of certain gross morphological features and the growth rate. Hubbs (1926) reviewed the literature as it applied to fishes. Information on other animals is scanty.

Differences in size, correlated with temperature, were usually thought of as occurring among wide-ranging species in the seas. The purpose of this paper is to call attention to size-temperature relationships among fishes of the United States east coast. The differences in this respect between fishes of the Gulf Coast and those of the Middle Atlantic states have an effect upon the commercial fisheries and upon the life histories of the species concerned in the two regions.

Discussion

Several species of fishes extend from the western Gulf of Mexico around the Florida Peninsula to Long Island, thus covering a coastline of about 3,000 miles and a north to south direction of 1500 miles. Some extend into the West Indies and beyond. Greater size of these fishes along the Middle Atlantic states as compared to those in Gulf waters is shown by several facts. Several fishes utilized commercially in New Jersey, Virginia and other Atlantic states are never thought of as anything but trash fish along the Gulf Coast. The chief ones are the harvestfish (*Peprilus paru*), the butterfish (*Poronotus triacanthus*), the spadefish (*Chaetodipterus faber*), the spot or flat croaker (*Leiostomus xanthurus*), and the croaker (*Micropogon undulatus*). The first 3 species have never been taken commercially along the Gulf Coast. After several years acquaintance with *C. faber*, I learned with considerable surprise that a size of 10 to 12 pounds is not uncommon for this species in Chesapeake Bay (Hildebrand and Schroeder, 1927). The amount of commercial production of these species for several of the Atlantic states can be seen in any of the annual statistical reports of the U.S. Fish and Wildlife Service. The production of the first 3 is small. In 1934, a year picked at random, according to federal statistics (Fielder, 1936), the Atlantic states produced 7,443,250 pounds of spots while the Gulf states produced 13,800

pounds. Nevertheless, this fish is very common on the Gulf Coast and may be among the upper 10 in species mass (see Gunter, 1945: tables 60–65). Pearson (1929) concluded that on the Texas Coast most of these fish died after the first spawning, and my data (Gunter, *op. cit.*) corroborated that view. First spawners are probably in year-class II. Among 1,264 fish, from Gulf waters, I took only 15 above 255 mm. in length. Most spots simply do not attain commercial size on the Gulf Coast.

The croaker deserves special mention. In Virginia this fish grows to a size of 4 to 5 pounds and the fishery for it may amount to over 40,000,000 pounds a year. In Texas they seldom attain an important size, and evidence has been presented (Gunter, *op. cit.*) that usually they die at the end of two years at a length of about 250 mm. Thus, in spite of the fact that the croaker is one of the most abundant of all fishes and is certainly among the upper 4 in species mass in this area (Gunter, *op. cit.*), few fish grow to market size. According to Fiedler (1936), in 1933 the Gulf states produced 683,300 pounds of croakers and the Atlantic states produced 31,812,050 pounds. In the federal statistics for 1938 (Fiedler, 1940), the same areas were credited with a production of 202,200 pounds and 64,763,000 pounds, respectively. Every few years on the Texas Coast, at irregular intervals not well known, there are runs of croakers that weigh from 2 to 4 pounds. They are distinguished by the name "golden croakers." They are, however, the same fish and are comparable in size and weight to the Virginia fish. They are not to be confused with the West Indian croaker (*Micropogon furnieri*), which has been reported from the southern tip of Texas. Why certain year-classes attain greater size than others is unknown. Possibly some large croakers are present every year, but are not numerous enough to be of particular note in the commercial fishery. Weymouth (1918) has shown that on the Pacific Coast of this country animals attain a larger size when the growing (warm) season is longer. Presumably on the Gulf Coast the situation would be reversed and larger size would be correlated with colder years and retardation of the rate of growth. Years with colder extremes do occur (Gunter, 1948), but there is no evidence that they are correlated with the larger croakers. Furthermore, such fish probably take 4 or 5 years to reach maturity. Possibly they abandon the warm, shallow bays for the colder waters of the Gulf and grow up there, and do not follow the usual life cycle. In any case it is known that large croakers, similar to the "hardheads" of Virginia, appear occasionally along the Texas Coast.

It is well established that the redfish (*Sciaenops ocellata*) on the Texas Coast does not spawn until a length of 32 inches is reached (Pearson, 1929). However, during the past 5 years 3 redfish, with roe at smaller sizes, from the south Texas Coast have been brought to my attention. All were taken within 100 miles of Mexico. Two were 17 and one was 16 inches in length. Inquiry among fishermen who work down the Mexican Coast has brought the information that similar, small, sexually mature redfish are not uncommon south of the Rio Grande, but are very rare north of it. At my request, Mr. C. E. Dawson, Jr., of the University of Miami Marine Laboratory, has made some inquiry among the fishermen of the southern part of the west Florida Coast. They state that the smallest redfish with roe there are about 12

inches long, but that the average minimum length is 15 inches. Small redfish with roe on the south Texas, Mexican, and southern Florida coasts correspond to what we would expect from rising temperatures southward in those regions. So far as is known no redfish of the northern Gulf Coast become sexually mature at less than 32 inches in length.

Great numbers of large croakers are produced in Chesapeake Bay, while

TABLE I

A LIST OF FISHES FROM CHESAPEAKE BAY AND THE TEXAS COAST WITH MAXIMUM SIZES IN MILLIMETERS RECORDED BY HILDEBRAND AND SCHROEDER (1927) AND BY GUNTER (1945).

Only those species for which the authors recorded 10 or more specimens are listed

Species	Chesapeake Bay		Texas	
	Size	Number	Size	Number
Anchoa mitchilli	97	many	95	11,054
A. hepsetus	152	many	141	1,283
Dorosoma cepedianum	330	31	280	692
Cyprinodon variegatus	76	many	93	6,673
Lucania parva	58	many	53	476
Membras vagrans	115	numerous	98	710
Mugil cephalus	381	many	356	4,940
Mugil curema	150	many	303	619
Trachinotus carolinus	200	24	185	556
Caranx hippos	195	15	285	34
Poronotus triacanthus	235	many	200	47
Orthopristis chrysopterus	285	many	227	290
Lagodon rhomboides	185	many	225	907
Archosargus probatocephalus	15 lbs.	many seen	405	25
Archosargus probatocephalus	(30 lbs.)	(observed)	—	—
Micropogon undulatus	508	numerous	370	15,847
Pogonias cromis	(40 lbs. seen)	17	460	174
Bairdiella chrysura	225	many	164	236
Leiostomus xanthurus	345	many	282	1,264
Menticirrhus americanus	393	many	318	326
M. littoralis	160	many	340	54
Cynoscion nebulosus	(16 lbs. observed)	many	515	464
Chaetodipterus faber	10 to 12 lbs. not uncommon	13	195	23
Gobiosoma bosc	60	many	52	173
Chilomycterus schoepfi	225	11	273	26
Achirus fasciatus	202	numerous	140	98
Etropus crossotus	115	20	156	210

on the Gulf Coast the lives of the fish are foreshortened and large ones are very much in the minority. The same holds true of the spot. Nevertheless, one of the most striking things about the fish populations of the shallow Gulf waters is the predominance of the family Sciaenidae, led by the croaker, as I have shown in several papers (summarized in Gunter, 1945). The contrast of the two abundant croaker populations—that of the Middle Atlantic states which supports a large fishery, and that of the Gulf states which supports none of consequence—raises interesting fishery and ecological questions.

In contrast, the size and length of life of the redfish (*S. ocellata*) on the Gulf Coast are not foreshortened. Only a few small spawning redfish are found in the Gulf and these are to the south. Also in contrast to the croaker and spot, the chief fishery center is farther south, lying in Florida and Texas, the only two states which produce over a million pounds a year. Spots, croakers and redfish all show the same general response to higher temperatures southward, in a modification of their life cycle; but in the two croakers the feature makes itself apparent at higher latitudes. The range of all 3 species is generally given as Massachusetts to Texas. However, *S. ocellata* is the most southerly fish, and when the southward range of the 3 species is finally known it will doubtless be found that the redfish extends farthest in that direction.

More evidence of a difference in maximum size between Middle Atlantic and Gulf fishes is shown by certain published measurements from the two areas. Hildebrand and Schroeder (1927) recorded some 45 species of fish from Chesapeake Bay which Gunter (1945) also listed from the Texas Coast. In both reports maximum sizes were usually given, but for a few species this size was not given in one paper or the other. For some other species large fish were known or observed from Chesapeake Bay, but were not measured or preserved. All species for which the authors reported 10 or more specimens and gave the maximum sizes are shown in Table I. Therefore, 19 species listed by Hildebrand and Schroeder and by Gunter are omitted from the present discussion because obviously the records are not representative of the species. These include rare strays into the Chesapeake region and some that were rarely caught in one region or the other. Nevertheless, 14 of the rarely caught species are recorded as being larger from Chesapeake Bay. Table I gives the maximum sizes of species for which the authors could or probably were getting more representative samples from the population. These do not necessarily include the very largest fishes residing in the two areas. Hildebrand and Schroeder did not always give the number of specimens in their collections and the numbers taken in the two areas cannot be compared. Nevertheless, it is significant that of 26 comparable species from the two localities, for 18 of them the larger fishes were recorded from Chesapeake Bay. The exceptions were *Cyprinodon variegatus, Mugil curema, Lagodon rhomboides, Menticirrhus littoralis, Caranx hippos, Chilomycterus schoepfi* and *Etropus crossotus*. Larger *L. rhomboides* than those measured are commonly caught in Chesapeake Bay, and in some years a few thousand pounds are marketed.

Lastly, some consideration should be given to the differential effect of temperature on morphogenetic processes. Divergence or differentiation parallels the growth rate, both in rate and degree (Hubbs, 1926). Apparently any growth-retarding factor has the same effect, in this respect, as low temperature. A fast-growing fish may differentiate faster in spines, scales, bony plates, number of vertebrae, body proportions, etc., but differentiation stops sooner than in slow-growing fish; and although at comparable sizes a cold-water animal may be more juvenile in appearance than specimens from warmer waters, in the long run it comes to possess more spines, meristic elements, etc. In other words, in general the final degree of differentiation

in a cold-water fish is greater than in warm water congeners, although the rate is slower. Hubbs (*op. cit.*) discussed the few exceptions to this general rule. These facts should be held in mind by taxonomists and students of speciation. Certain constant differences in fishes that are correlated with geographic distribution may be no more than differences produced directly by the temperature of the environment. As such they are not indicators of genetic or hereditary separation at all.

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Preseasonal Breeding by the Bridled Shiner, *Notropis bifrenatus*, Induced Under Light-Temperature Control

By ROBERT W. HARRINGTON, JR.

LITTLE attention has been accorded the effects of environmental factors in the control of the fish sexual cycle. Observations, alone, permit the correlation of episodes in the cycle with changes in the expression of environmental factors, but are incapable of revealing the causal relations between the two.

Both observations and population analyses have afforded several contributions (Harrington, 1947*a*, *et seq.*) to the biology of *Notropis bifrenatus* (Cope), but have failed to explain the relations between environmental factors and the onset of the breeding cycle. A preliminary experiment is reported here, in which the separate effect of light on the cycle of this species is investigated. In brief, two tanks of fish were regulated to maintain the same temperature, but one was subjected to a long, and the other to a short light ration.

Craig-Bennett (1931), Hoover and Hubbard (1937), Matthews (1939), Burger (1939, 1940), Bullough (1939, 1941), and Merriman and Schedl (1941) have published experimental data concerning the effects of light and temperature on the piscine sexual cycle. To date, experiments with regard to both these factors are confined to five species of fish, belonging to four families. The species concerned are too few to disclose a phylogenetic pattern, if such exists. Most of them have been incompletely studied experimentally, and for some of them, certain of the conclusions are tentative, so that generalization is unwarranted. However, there is evidence for certain fish species that a suitable rise in temperature alone induces the completion of gametogenesis and that light is without effect on the breeding cycle, but that for other species the completion of gametogenesis requires an increase in the daily light ration.

Material and General Methods

Specimens of *Notropis bifrenatus* were collected on October 4, 1948, in Wash Brook, a tributary of the Park River, in Bloomfield, Connecticut, situated at 41° north latitude. Fifty-nine fish were retained, and were placed in a single aquarium, where they remained at room temperature, in an unheated room with the windows open. Throughout the period of this inquiry, all fish were fed exclusively on dried, commercial, tropical fish food. Terminal dissections disclosed a consistent deposition of fat, in spite of the departure from a normal diet (cf. Harrington, 1948*b*). Measurements taken at the time of dissection proved them to be homogeneous: males ranging 39–44 mm. in standard length (2–2$^{3}/_{16}$ inches in total length); females, 39–44 mm. in standard length (2–2$^{3}/_{8}$ inches in total length). Previous studies (Harrington, 1948*a*) permitted their identification as maximum-sized adults of the same year class. The maximum standard length recorded for the species is 48 mm.

Segregation of Experimental and Control Fish

On December 4, 1948, they were segregated into two groups, destined to become experimental and control fish, respectively. Twenty-one individuals were allotted to the control tank and 38 to the experimental tank. The ratio of water volume to fish number was adjusted to allow one gallon per fish in each tank. Aerators and filters were regulated to the respective water volumes, and the amounts of food to the numbers of fish.

With the separation of the fish into two groups, the water temperatures of the two aquaria concerned were regulated throughout the remainder of this investigation so as to be as nearly equivalent and constant as possible. Relying on prevailing outdoor temperatures to depress the water temperatures below the desired point, they were then raised to this point, and maintained there by submerged electric heaters, thermostatically controlled. The thermostats were adjusted to maintain a temperature of 67.5° F. in each tank. This value was selected to be well above a possible threshold temperature as surmised from pertinent field data (cf. Fig. 1) and high enough to be capable of adequate control by the above method. Throughout the pre-experimental period, October 4 to December 31, both before and after the segregation of the fish, all fish were subjected to the normal, waning daylight periods prevalent at latitude 41° north (cf. Fig. 1). It is obvious that these fish were kept at a mean temperature much higher than that maintained concurrently in their natural habitat.

To determine the homogeneity of the 59 specimens at the commencement of the experiment, January 1, 1949, fish from both tanks were sacrified on that date. The impossibility of recognizing sex externally in this species except during the breeding season is a disadvantage in sampling. The sex and standard lengths of the fish sampled were: from the future control tank, 2 males, 42–44 mm. and 3 females, 41–45 mm.; from the future experimental tank, 4 males, 41–44 mm. and 4 females, 39–44 mm. There was no significant size difference in the ovaries of females from the two aquaria, and his-

tological sections showed the range in testicular development to be approximately the same in the males of both groups. As might have been anticipated at the temperatures maintained, by analogy with Bullough's (1939) results with the cyprinid, *Phoxinus laevis*, the early stages of spermatogenesis had been attained but not surpassed.

Experimental Period of Differential Lighting

Beginning January 1, 1949, the experimental tank was exposed to sufficient artificial illumination to bring to 17 the total number of hours of light per day, as indicated in Figure 1 by the horizontal broken line. Normal daylight was supplemented by over-lapping light increments provided by three Westinghouse, 25-Watt, unfrosted, showcase light bulbs installed 23 inches above the bottom of the tank.

The control tank was enclosed in a compartment proofed against the penetration of artificial light, but built around a north window, so that it received only normal daylight in the amounts afforded at the latitude and season concerned. This is indicated in Figure 1 by the broken-line extension of the curve for normal light periods at 41° north latitude.

The temperatures in both tanks were virtually the same from the time the fish were segregated and throughout the experimental period of differential lighting. In the control tank, the mean temperature during this period was 67.6° F., in the experimental tank, 67.4° F. With the exception of parts of 3 days, control and experimental temperatures never differed more than two degrees, and on all but 9 days, were not more than a degree apart. In Figure 1, the mean aquarium temperatures are plotted as a single line, broad enough to include 67.4° F. and 67.6° F.

On February 14, 1949, all the control fish and all but 22 of the experimental fish were sacrificed, thus terminating the experiment.

Post-Experimental Period

The surviving experimental fish were kept on the same light ration, but at a water temperature reduced to a mean of 65° F., as indicated in Figure 1 by the lower horizontal temperature line, which serves to identify the post-experimental period. During this period, February 15 to March 29, varying numbers of fish were sacrified on different dates, final survivors being killed on March 29. It should be mentioned here that, during the interval extending from the collection date to the termination of the experimental period, not a single fish died or manifested ill health, but that in the post-experimental period, after the middle of March, one male died and 6 other fish, representing both sexes, were either emaciated or sickly.

Results

On January 22, the first traces of breeding color were detected in some of the males of the experimental tank, and by this time, the deeper bodies and

more prominent urogenital papillae of the females permitted the external recognition of sex in the larger individuals. No fish in the control tank showed any external changes.

On February 14, 6 weeks after the beginning of differential light control, and without prelude, spawning occurred in the experimental tank, and the deposition of eggs was observed a half a dozen times during the day. In contrast to this, the fish in the control tank continued to show no change in either appearance or behavior over that displayed at the time they were collected, on October 4, 1948.

On February 14, 4 experimental males, 42–45 mm. in standard length, and 4 females, 41–45 mm., were sacrificed. Inability to distinguish males from females in the control tank necessitated the sacrifice of all 16 fish remaining. They proved upon dissection to include 4 males, 41–45 mm., and 12 females, 39–47 mm. The ovaries were dissected out and preserved, and serial sections were made of the testes.

Thus, for a balanced comparison between the two groups, 4 males and 4 females were available from each. A detailed description of the histological picture will be deferred, to be considered in connection with an experiment employing a larger number of fish and designed to both complement and supplement the one reported here. However, it seems fit to mention at this time that active gametogenesis was evident in the testes of all 4 experimental males. Not only were considerable numbers of spermatozoa present in ducts and tubules, but the loose structure of the testes suggested that some had been voided already, as observation had attested in an undetermined number of cases.

In contrast, the testes of the control males were compact. Three males showed no advance over the conditions prevailing on January 1, and the fourth and largest was in the same condition except for discontinuous areas at one end of the testes, where the later stages of gametogenesis were observed.

Although there was an appreciable size range in the ovaries within each group, the average size was obviously less for the controls than for the experimentals.

Among those fish retained in the experimental tank beyond the duration of the experiment, sporadic breeding behavior but no natural spawning was observed. It had occurred, however, because recently hatched larvae appeared on the sides of the tank 4 days after the last adults were killed. Most if not all eggs spawned by this species in aquaria are eaten sooner or later.

On March 19, a 42-mm. female and a 44-mm. male were stripped, and fertile eggs were obtained, which hatched out free-swimming larvae 4 days later, on March 23. Development differed in no way from that described in detail for the normal breeding season (Harrington, 1947*a*.). The stripped pair recovered later from the effects of handling, and spawned independently on the same day.

Discussion

Observations of the episodes in the normal breeding cycle of *N. bifrenatus* (Harrington, 1947*b*) permit certain comparisons between normal and induced

cycles. The modalities of both cycles are expressed graphically in Figure 1. Before considering these, it is pertinent to inquire into the validity of comparing field observations made at 43° north latitude with an experiment conducted at 41° north latitude. Reference to Marvin's (1944) sunshine tables reveals that from March 6 to April 27, the normal daily light periods are almost identical at the two latitudes. Beyond this date, these periods at 43° north latitude, where the field observations were made, become gradually longer than those at 41° north latitude, where the experiment was conducted. The greatest difference, occurring at the period of maximum daylight in mid-June, amounts to only 18 minutes a day. Thus there seems to be no reason to discredit a comparison of cycles at these two latitudes.

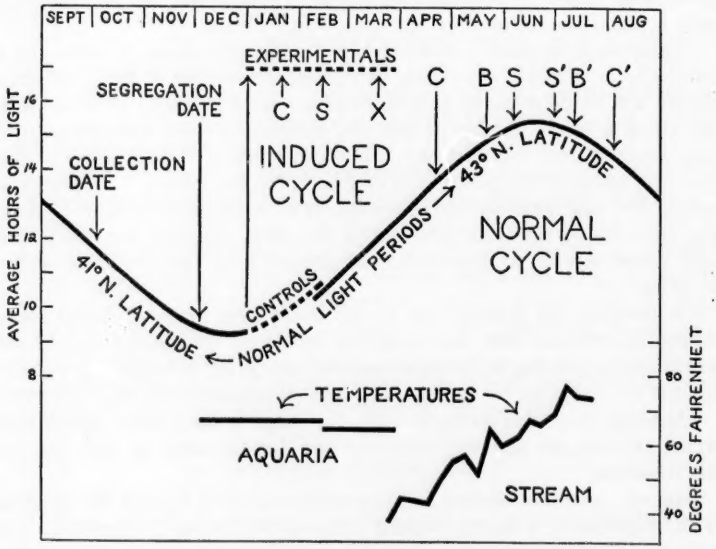

Fig. 1. Episodes in normal and induced breeding cycles of *Notropis bifrenatus* compared. First and last traces of breeding coloration, C and C'; of breeding behavior, B and B'. First and last spawning observed, S and S'. Fertile eggs obtained by stripping a pair, which spawned later the same day, independently, X.

In nature, the first and last traces of breeding coloration were observed on April 22 and August 5, respectively, as indicated by C and C' on the curve for normal daylight periods at 43° north latitude (Fig. 1). Light curves are plotted from the data of Marvin (*loc. cit.*). The first and last traces of breeding behavior were observed on May 22 and July 13, respectively, as indicated by B and B' on the same curve. Actual spawning was observed only

between June 7 and June 30, as designated by S and S′ on the same curve. Diurnal mean stream temperatures are plotted as weekly averages.

Considering the chronology of the breeding episodes alone, it will be seen that the inception of color development was experimentally advanced exactly 3 months. Since no breeding behavior was observed in the experimental tank prior to spawning, no comparison is possible for breeding behavior unaccompanied by spawning, although it is not to be concluded that such failed to occur in the tank, as it might well have passed unnoticed. The inception of spawning was advanced, according to these observations, from June 7 to February 14, a period of about 3 months and 7 days. Reference to Figure 1 discloses an apparent telescoping of the episodes in the induced as compared with the normal cycle. In the induced cycle, the inception of spawning occurred 33 days after that of color development, in the normal cycle, 46 days after. Although it is recognized that the very first spawning may have been overlooked in the field, it is unlikely that it escaped notice for long, since protracted daily observations were made.

A comparison of stream and aquarium temperatures shows that functional maturity occurred in nature at temperatures much lower than that set for the experiment, for breeding color became evident following a week in which stream temperatures averaged 50° F., the first breeding behavior following a week when the average was 56° F., and the first spawning following a weekly average of 53° F.

Bullough (1939) demonstrated that for *Phoxinus laevis*, light, although necessary for the completion of gametogenesis, produced no effect unless temperatures were above a certain threshold. In the absence of light, only the early stages of gametogenesis could be induced and only at temperatures above this threshold. Although this experiment on *Notropis bifrenatus* was not contrived to investigate the separate effects of temperature, it does show that if such a temperature threshold exists for this species, it is at or below 67.4° F., because at this temperature level, the early stages of gametogenesis occurred under a short light ration, and spawning occurred under a long light ration. The field data, in addition, show that if there is a threshold, it is to be sought at a level of 50° F. or less.

Since in nature the first traces of breeding color appeared when the normal daylight hours amounted to 13.7, the first breeding behavior at 14.9 hours, and the first spawning at 15.3 hours, it is probable that a light ration of considerably less than the 17 hours per day maintained during the experiment would have proven effective.

Before concluding the comparison of normal and induced cycles, further mention is due the fish retained in the experimental tank beyond the duration of the experimental period. These were retained partly to ascertain whether, with the lapse of time, breeding color would acquire the maximum intensity attained in nature. In the field, this was achieved 46 days after the first appearance of color, but in the post-experimental fish, 56 days after the first traces appeared, the intensity was far short of that developed in nature. This might be ascribed to dietary deficiency or perhaps to sub-normal secretions of sex hormone, and is a problem for future investigation.

Summary

1. The bridled shiner, *Notropis bifrenatus* (Cope), spawned on February 14, 3 months in advance of its normal spawning period, after subjection to 17 hours of light per day, beginning January 1, 1949. It was maintained at room temperature from October 4 to December 4, 1948, and at a mean temperature of 67.4° F. thereafter, and was exposed merely to normal fall and winter daylight from October through December.

2. Control fish maintained at virtually the same temperatures, but exposed merely to normal daylight throughout the same periods, failed to develop the secondary sexual characters peculiar to the breeding season, showed no evidence of breeding behavior, and failed to spawn.

3. A comparison of normal and induced breeding cycles suggests the feasibility of inducing breeding at temperatures somewhat lower and under a light ration of several hours less per day than was employed in the experiment.

4. It is concluded that the experiment provides strong presumptive evidence that this species, like the European *Phoxinus laevis* of the same family, requires light for the completion of sexual maturity. The separate effect of temperature was not investigated experimentally.

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A New Subspecies of the Darter *Hololepis barratti* from Western North Carolina

By JOSEPH R. BAILEY

DURING the course of a fishery survey[1] of the streams of the French Broad Watershed of North Carolina in the summer of 1947, a series of darters of the genus *Hololepis* was secured from a pond near the French Broad River, a few miles south of Asheville. This genus, notably lowland in habitat elsewhere in its range (Hubbs and Cannon, 1935), is almost restricted to the Atlantic and Gulf Coastal Plains and the Mississippi Embayment, scarcely attaining elevations of over 500 feet. Finding it at about 2000 feet in a valley of the southern Appalachians was therefore wholly unexpected. Its occurrence here was first thought to be the result of an introduction, but on closer inspection the population appears to represent an undescribed form close to *Hololepis barratti* (Holbrook). The type series was collected by Yates Barber and Frank Cross. To these men and to Fred Morrison I extend my sincere thanks for their industrious and able field assistance during the 1947 survey. I also wish to thank my brother, Dr. Reeve M. Bailey, Curator of Fishes at the University of Michigan Museum of Zoology, for placing at my disposal large collections of *Hololepis barratti* for comparative study.

The form of description follows closely that adopted by Hubbs and Cannon (1935) in their excellent review of the genus. Figures in parentheses refer to data for the holotype, unless otherwise stated.

[1] Carried out for the North Carolina Wild Life Resources Commission, Raleigh, North Carolina.

Hololepis barratti ***appalachia,*** subsp. nov.

HOLOTYPE.—University of Michigan Museum of Zoology No. 156224, an adult male 37 mm. in standard length, collected from a pond south of the mouth of Bent Creek, about 300 feet west of the French Broad River, and about 7 miles south-southwest of Asheville, Buncombe County, North Carolina, July 14, 1947, by Yates Barber and Frank Cross.

PARATYPES.—Forty-nine specimens, UMMZ No. 156225, juveniles and adults of both sexes, collected with the holotype. Eleven specimens from the type locality collected on June 7, 1949, and retained by J. R. Bailey.

DIAGNOSIS.—A *Hololepis* differing from *H. b. barratti* in usually having 8 instead of 7 soft anal rays, the preopercle with a more serrate posterior upper margin, and a lower ratio of pored to unpored scales in the lateral line row.

BODY.—Elongate, somewhat compressed, not differing appreciably from the typical subspecies.

HEAD.—Muzzle rather sharp; mouth subterminal, slightly more oblique than in *b. barratti*; lower jaw included. Preopercle with vertical limb moderately serrate, 4–37 serrations on both vertical limbs (21). Gill membranes rather broadly connected: distance from angle to tip of snout decidedly greater than half length of head.

PROPORTIONS.—Not differing visibly from the typical subspecies.

GENITAL PAPILLA.—In mature female without basal enlargements, conical or slightly bilobed at tip, extending to origin of anal fin or overlapping origin of anal fin for half the papillary length. Orifice plicate, opening on ventral surface about ⅓ distance from tip to base. In fully mature fish turgid, held out at an angle from the body, 2 mm. long in a 42-mm. fish. Genital papilla of male minute, conical, in a depression behind the anus.

FIN RAYS.—Dorsal, VIII to XI—10 to 12 (XI—11); anal, I or II—7 to 9 (II—9).

SCALE ROWS.—Two to 4—48 to 60—8 to 11 (3-57-9).

LATERAL LINE.—Moderate for a species of *Hololepis,* shorter than in *b. barratti,* usually ending below the second third of first dorsal. Pored scales 12 to 25. Unpored scales in same row 27 to 44 (13 pored + 2 unpored + 2 pored + 40 unpored = 15 pored + 42 unpored). Ratio of pored to unpored scales 0.27 to 0.93 (0.36). Lateral line, including its rudimentary extension, strongly elevated as in *b. barratti.* Scales above lateral line typically 3; scales below rudimentary extension of lateral line 8 to 11 (9 in 24 out of 39 specimens).

SQUAMATION.—Breast covered with exposed ctenoid scales, exceptionally embedded. Nape well scaled. Cheek scales exposed and ctenoid, even ventrally in half-grown. Opercles covered with ctenoid scales. Parietals scaled except for a broad scaleless area behind the coronal pore and a continuous narrow median strip extending to the supratemporal canal. Interorbital with numerous ctenoid scales.

HEAD PORES.—About as in *b. barratti.* Interorbital pores constantly lacking. Infraorbital canal interrupted, with 1, occasionally 0, pore behind the

break, and with 3 pores above the upper jaw (0–3). Preoperculomandibular pores 9 (10 on 1 side of 1 specimen). Supratemporal canal regularly complete in half-grown and adult fish.

COLORATION.—Median sides with a row of 10 to 13 small dark blotches, the first above the tip of the opercle, the others following the mid-line of the sides. These blotches are smaller and less distinct than in *b. barratti* and poorly defined except in juveniles and half-grown specimens. Back with a series of about 11 dark saddles as in *b. barratti,* but tending to be less distinct except in young. Melanophores large, more generally distributed outside the areas of major concentration than in *b. barratti.* Upper sides in young almost without pigment, varying in older specimens to a monotone or variegated ground color almost as dark as the lateral and dorsal blotches. Lateral line marked by a narrow light line. Base of caudal with 4 dark spots in a vertical row; the lower one of the median pair darker and larger than any of the others, occasionally approached in size and intensity by the upper median spot. A slender dark bar behind base of pectorals usually present in males, absent or interrupted in females. Opercle mostly dark. Cheeks and mandibles with small dark blotches or round dots. Four short lines or spots radiating from the eye: 2 vertical and 2 horizontal, the pigment extending on the cornea from the dorsal bar. Parietal region dark.

Female with throat and breast sparsely dotted with dark, belly light; sides below lateral blotches and lower surface of caudal peduncle generously sprinkled with dark spots and small blotches; a concentration of pigment to form a dark median ventral line on the caudal peduncle. Male with sides adjacent to belly lacking the blotches of the female, this area and the belly pigmented more densely than in *b. barratti,* with small evenly scattered melanophores. Near the anal fin and caudal peduncle these tend to outline the scale pockets, producing a reticulate pattern under magnification.

The membrane of the spinous dorsal of the male has dark pigment concentrated on the lower third (especially anteriorly) and on the marginal or submarginal area (especially posteriorly). Soft dorsal more or less uniformly speckled. Rays of both fins faintly barred. Anal fin of male with membrane sparsely to rather densely pigmented, especially basally. Caudal fin of male with about 5 vertical bars. Pelvics with scattered pigment on the membranes, especially medially; bars absent. Pectorals very faintly barred. Fins of female generally similar but with little or no pigment on membranes and with the barring on spines and rays better defined.

COMPARISONS.—Three principal characters distinguish *barratti* from *appalachia,* as indicated in the diagnosis. The data for these and certain other meristic characters of the two forms are presented in Table I. The number of scales in the lateral-line row average about the same, but the pored scales average fewer and the unpored scales more in the new form so that the ratio of pored to unpored scales differs very significantly, permitting a separation of about 80 per cent of the specimens on this character.

Anal ray counts were not given in detail by Hubbs and Cannon (1935) for *barratti,* beyond the statement that there are 2 spines and 6 or 7 soft rays. Seven proves to be the modal number of soft rays with 6 and 8 the

extremes. The modal number in *appalachia* is 8 with extremes of 7 and 9.

TABLE I

SUMMARY OF CERTAIN MERISTIC CHARACTERS IN THE SUBSPECIES OF *Hololepis barratti*

Character		*barratti**	*appalachia*
Dorsal spines	VIII	—	3
	IX	8	20
	X	10	32
	XI	5	5
	XII	2	—
	XIII	—	1
	Mean	10.0	9.7
Dorsal soft rays	9	1	
	10	6	16
	11	16	36
	12	2	8
	13		1
	Mean	10.8	10.9
Scales above lateral line	2	10	2
	3	9	36
	4		1
	Mean	2.5	3.0
Scales below lateral line	8		5
	9	9	24
	10	9	8
	11		2
	Mean	9.5	9.2
Serrae on vertical limbs of both preopercles	0	36	
	1–4	30	1
	5–8	16	5
	9–12	15	8
	13–16	1	7
	17–20	2	5
	21–24	—	5
	25–28	2	5
	29–32		2
	33–36		—
	37–		1
	Mean	4.1	16.8
Pores, infra-orbital canal	0–3		4
	1–3	160	26
	2–3	24	
Anal soft rays	6	17	
	7	99	18
	8	25	36
	9		7
	Mean	7.1	7.8
Ratio of pored to unpored scales in lateral line row	.28		1
	.33		3
	.38		4
	.43	1	7
	.48	3	10
	.53	1	2
	.58	3	3
	.63	2	1
	.68	6	3
	.73	6	1
	.78	3	3
	.83	5	—
	.88	3	—
	.93	3	1
	.98	6	
	1.03	1	
	1.08	3	
	1.13	3	
	1.18	2	
	1.23	—	
	1.28	—	
	1.33	—	
	1.38	3	
	Mean	84.7**	51.8

* Data from Hubbs and Cannon (1935, Table II) except for anal soft rays and preopercular serrae.

** Mean approximated from data presented.

In their treatment of *barratti* Hubbs and Cannon (1935: 59) described the preopercle as "smooth or with at most a few slight crenations" and in the key it is placed under "1*b*.—Preopercle strictly entire . . . ." By directing a fine stream of compressed air on the preopercular margin, the concealing skin may be shrunk so that hidden serrations may be counted under proper magnification and in good light. Using the total number on both sides as a basis for comparison, it is demonstrated that *appalachia* has a more fully serrate preopercle although *barratti* usually has a few serrations (Table I). Data on this character are restricted to specimens over 29 mm. in standard length. Smaller specimens may show well developed serrae, but there is evidence that the number averages smaller in juveniles.

TABLE II

COMPARISON BETWEEN THE SUBSPECIES OF *Hololepis barratti* IN THREE DIAGNOSTIC CHARACTERS

Character	*barratti*	*appalachia*
Anal soft rays	82.3% 6 or 7	70.5% 8 or 9
Ratio of pored to unpored scales in lateral-line row	81.5% over 0.655	79.5% less than 0.655
Serrations on vertical limbs of both preopercles	91.2% 10 or fewer	76.8% 11 or more

According to the conclusions of Hubbs and Cannon (1935: 21–22) *H. barratti* is rather distantly related to *H. serrifer*, yet in the characters of preopercular serration and form of the genital papilla in the female, characters upon which these authors based their primary division in the generic key, this new race occupies an intermediate position, though it is otherwise very distinct from *H. serrifer*.

HABITAT AND DISTRIBUTION.—Known only from the type locality in the upper French Broad Valley which contrasts sharply with the coastal plain habitat of its closest relative, *H. b. barratti*, and its other congeners as well. This pond is about 50 feet wide and 2 or 3 times as long and has a bottom of sand and silt. The fish were taken in less than 4 feet of water from dense beds of vegetation which contained an abundance of green algae. The only associates of the darter were centrarchids, including *Chaenobryttus coronarius*, *Lepomis m. macrochirus*, and *Lepomis auritus* (an introduced species in the Tennessee system), all of which were common.

It is futile to speculate at this time on the distribution of this new subspecies. The survey under which the typical series was taken was concerned only with streams, and the few ponds, swamps and impoundments of the

watershed were not investigated, except, by chance, the type locality. Collecting in quiet and stagnant waters in the vicinity may show *appalachia* to be a characteristic form. The associated *Chaenobryttus coronarius*, another quiet-water species, also was not taken elsewhere in the course of the survey.

ORIGIN.—Four possibilities as to the origin of this population present themselves. First, invasion of the upper Piedmont and subsequent crossing of the divide between the French Broad and Atlantic coastal streams by a population derived from *b. barratti* or by a common ancestor from the southeast. This would involve crossing a divide which, at the present time, has an elevation of less than 2200 feet between the Green and the French Broad rivers east of Hendersonville. Second, immigration up the Tennessee Valley to the French Broad Valley. This possibility is enhanced by a specimen of *H. barratti* (UMMZ No. 105397) collected by M. V. Parker from Reelfoot Lake, Tennessee. This specimen is typical neither of *b. barratti* nor of *b. appalachia*. It has D. XI–9 (fourth soft ray abnormal and possibly representing 2 rays); A. II–8; preopercular serrae 0–1; and lateral line row of 20 pored and 36 unpored = 56 scales, ratio 0.56. The ctenii of the scales appear rather stronger than in either form. This specimen may prove to represent a third subspecies of *Hololepis barratti*. Third, introduction from an undiscovered and previously unnamed population. Fourth, introduction of a small atypical sample of *barratti* in which the characters diagnostic of *appalachia* were predominant.

More adequate collecting of the quiet water habitats in the Piedmont and upland valleys may throw additional light on the subject. Due to the scarcity of such habitats in the upland areas they have escaped the attention of fish collectors.

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Ichthyological Notes

THE CAPTURE OF A WATTLED EEL-POUT, *LYCODES PALEARIS*, FROM FIDALGO ISLAND, WASHINGTON, AND THE DISTRIBUTIONAL RECORD OF THIS SPECIES.—On June 15, 1949, Mr. Harold G. Hebard, a student at the Walla Walla College Biological Station at Shipharbor, Fidalgo Island, jigged a copper rock-fish, *Sebastodes caurinus* (Richardson), which was about 500 mm. in total length. During the process of removing the hook, Mr. Hebard noticed an eel-like creature in the mouth of the scorpaenid. The "eel" was brought to the laboratory and identified as the wattled eel-pout, *Lycodes palearis* Gilbert. The fish was in excellent condition, aside from the fact that about 3 mm. was missing from the tip of the caudal fin. Apparently the eel-pout was in the process of being swallowed just at the time the rock-fish was hooked. The specimen was a young adult, 227 mm. in total length, having the following measurements and counts: head 4.5 in standard length; depth 8.3 in standard length; eye 7.4 in head; D. 105 (counted to middle of caudal with which it is confluent); A. 89; V. 3. The morphological details were in agreement with the description as given by Jordan and Everman (1898, Bull. U.S. Nat. Mus., 47 (3): 2466). This particular specimen was captured at Shannon Point, at the northwest tip of Fidalgo Island, in 6 fathoms of water. Shannon Point is a rocky, unprotected part of the island, which supports a dense growth of algae. The specimen has been placed in the fish collection of the School of Tropical and Preventive Medicine.

Lycodes palearis is known to range from Puget Sound to northwestern Alaska. The species was first described by Gilbert (1895, Rept. U.S. Fish Comm., 19: 454) from 3 specimens taken in Bristol Bay, in 1890, at "Albatross" stations 3253 and 3254, in 36 and 46 fathoms. It was not recorded as being taken again until the summer of 1909 (Starks, 1911, Ann. Carnegie Mus., 7 (2): 201; Kincaid, 1919, an annotated list of Puget Sound fishes, State of Washington, Dept. Fish.: 43), when 4 specimens were taken by trawl in the vicinity of the San Juan Islands. The depth of capture was not given. Clemens and Wilby (1946, Fish. Res. Board Canada, Bull. 68: 190) state that the first specimen was taken from the waters of British Columbia in 1934 by an otter trawl at a depth of 40 fathoms in Active Pass. Three additional individuals were later secured in otter trawls, 2 specimens from Satellite Channel at a depth of between 30 and 50 fathoms, taken in 1941, and one from Active Pass at 35 fathoms in 1942 (Carl and Wilby, 1945, Canadian Field Nat., 59 (1): 29). To date, I have been unable to locate any additional records of the capture of this rare species.—BRUCE W. HALSTEAD, *Department of Ichthyology and Herpetology, School of Tropical and Preventive Medicine, Loma Linda, California.*

A CHANNEL CATFISH WITH A FORKED BARBEL.—Recently I rode in one of the glass-bottom boats at Silver Springs, Florida. In the extraordinarily clear water of the springs, these boats provide an unusual opportunity for the study of aquatic life (*cf.* Hubbs and Allen, 1943, Proc. Fla. Acad. Sci., 6 (3–4): III). On this particular occasion I noticed a large southern channel catfish (*Ictalurus lacustris punctatus*) with a forked barbel. The abnormal barbel was the large one descending from the upper jaw; it forked at a point about 1 cm. from the base. The fish swam slowly for some distance, just a few inches below the boat, and I was thus able to positively identify the form, to observe the forked barbel, and even to note a thin white line about the base of what I took to be the supernumerary fork of the barbel.

Often during the course of herpetological collecting I have encountered lizards (*Eumeces* and *Leiolopisma*) with one to as many as seven extra branches to the tail. In these forms, a broken tail is rapidly regenerated; several small injuries on the tail may result in the growth of as many supernumerary branches to the appendage. I suspect that a similar regenerative ability was responsible for the abnormal barbel in the present instance.—WILFRED T. NEILL, *Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.*

RESPONSE OF MINNOWS TO EARTH VIBRATIONS.—As Research Fellow of the Edmund Niles Huyck Preserve, I was able to spend the summers of 1948 and 1949 at the laboratory on the shore of Lincoln Pond near Rensselaerville, New York. On several occasions in 1948, at intervals of minutes, I saw thousands of young golden shiners, *Notemigonus crysoleucas,* flash synchronously at the surface of the water in a broad band that crossed the entire width of the pond and also in smaller areas separated by hundreds of feet—a phenomenon I had never before witnessed and for which, at the time, I had no explanation. The solution came with the discovery, in 1949, that vibrations which reached the water *through the earth* elicited an observable response from all the minnows that were swimming at or near the surface. They broke the surface in groups, that often extended for several hundred feet in various directions, in response to vibrations set up by slamming our cottage door, to pounding on a stake near the margin of the pond, and even to the forceful banging of a car door one hundred feet from the pond. Thumping on the sides and bottom of a boat in the midst of schools of minnows aroused no response. The performance of the minnows could be seen only when the surface of the water was perfectly smooth.

During the summer of 1948, much blasting was done in connection with road-building operations and it is probable that the minnows first observed were jumping in response to the vibrations thus set up.—SHERMAN C. BISHOP, *Department of Zoology, University of Rochester, Rochester, New York.*

MOLLIENESIA VERSUS *MOLLIENISIA* AS THE NAME FOR A GENUS OF POECILIID FISHES.—The generic name of the aquarium fishes commonly known as "mollies" has been spelled in various ways, most often *Mollienesia* or *Mollienisia* by recent authors. The history of the name has been recorded by Fowler (1945, Acad. Nat. Sci. Phila., Monog. 7: 246–247) who chose *Mollienesia.* Most other modern workers, however, continue to spell the name *Mollienisia.*

The original text spelling by LeSueur (1821, Jour. Acad. Nat. Sci. Phila., 2: 3), appearing as a boldface center head, was *Mollinesia,* but since the name was indicated in a footnote to be in honor of Monsieur Mollien, a typographical error is evident and emendation to *Mollienesia* seems proper. In the index the name is spelled as in the text. The name *Molienisia Latipinua* appears on the first printing[1] of LeSueur's plate, whereas it is given as *Molinesia Latipinna* on the reference to the plates (page 409). We are unable to discover any etymological reason for choosing between *–esia* and *–isia.*

Study of the three plates in the original article makes evident the gross carelessness of their preparation. *Lebia* Cuvier is misspelled *Lebias* on plate 2, where the new trivial name *ellipsoidea* is given as *Elipsoides.* On plate 3 the name *latipinna* appears as *Latipinua.* The numbered plates are bound in the sequence 3, 1, 2. We regard it as evident that the captions for the plates were set in haste and were not proofed by LeSueur. To accept *Mollienisia* is to disregard the formal text proposal and to select a spelling which is probably erroneous.

A pending change in the International Rules, which will invoke page priority in selecting names, may be cited by some as pertinent to this case. Since plate 3 faces page 3 of the text it may be contended that the ending *–isia* has page priority and that *Mollienisia* must be used. In view of the evidence submitted above we feel that such an argument carries the intent of the Law of Priority beyond reasonable bounds. Even if *Mollienisia* is considered to have priority over *Mollienesia* it should be noted that the ending *–esia* appears three times in the volume, *–isia* once, and it may be concluded that a typographical error is evident, just as *latipinua* is an obvious mistake for *latipinna.*

We believe that the evidence favors the use of *Mollienesia.* The question of spelling is of trifling importance but is brought out here in the hope that the discussion will lead to uniform usage.

Even though it may be found ultimately that *Mollienesia* is not separable generically from the older genus *Poecilia* (Hubbs, 1926, Univ. Mich. Mus. Zool., Misc. Publ. 16: 73), the question of spelling may be regarded as relevant since *Mollienesia* may be needed as a subgeneric name.—REEVE M. BAILEY and ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

[1] Information obtained from Mrs. Venia T. Phillips, Librarian of the Academy of Natural Sciences of Philadelphia.

FINE-MESH NETS FOR FISH COLLECTORS.—In preparation for qualitative surveys of Oklahoma rivers a search was made for fine-mesh material from which small (3- or 4-ft.) seines could be made. At the time, bobbinet was suggested by Mr. A. D. Aldrich, then with the Oklahoma Game and Fish Department. Mr. Aldrich informed me that they used such seines to capture the fry of fishes. I had previously used ordinary screen wire nailed between strips of wood which served for brails. The screen wire, though useful, proved to be too stiff and had a tendency to become permanently wrinkled at the lower edge.

It was, therefore, a pleasure to use bobbinet seines which were made by my wife, Leah Moore, who sewed a strip of canvas along the upper and lower edges doubled over to receive the cork and lead lines. These seines proved to be very effective, especially since they were so easily maneuvered in the many different habitats to be found in small creeks and rivers. The bobbinet was easily torn and the seines had to be discarded after two weeks of field work. Even though they soon had holes torn in them, I consider bobbinet seines far superior to the ordinary "common sense" seine, since the mesh is smaller and there is no tendency for the threads to separate, leaving long slits through which small fish can easily pass.

In the summer of 1948 we substituted nylon screen for the bobbinet and found it highly satisfactory. Two nylon nets were made by Mrs. Moore, and after two weeks of constant use on the Mountain Fork River in McCurtain County, Oklahoma, these seines were still in perfect condition, despite the fact that we often picked up large rocks. The mesh never separates and since nylon does not soak up water they dry rapidly and resist decay. The same two seines are still serviceable after two years use. In these seines we dispensed with corks, using only an upper brail cord of cotton and a heavily leaded bottom line.

Tests have shown that these small seines take more species of fishes per unit of time than larger and coarser-mesh seines simply because they can be maneuvered in less space, more quickly, and in a greater variety of habitats. They do not supplant the larger seine but supplement it. Skillful handling makes it possible to take not only tiny fishes but even larger ones such as the black basses Many small forms such as *Microperca* and *Elassoma* might well be missed entirely if larger seines alone are employed.

The nylon net is particularly desirable in riffle collecting where such crepuscular or semicrepuscular forms as *Schilbeodes* and many percids live. The net can be set so that a considerable flow of water passes through it and then by vigorous kicking in the rocks and gravel above, the fishes are dislodged and fall into the net. Small backwater areas can be blocked off and then each operator agitates the water with one foot followed quickly by raising the net. Such mud dwellers as the larvae of lampreys are easily taken by this means. When the larger seine fails most miserably in heavily vegetated waters, the nylon net yields results even by taking larger fishes using such cover.

We expect to try one more improvement over our first nylon nets in that the canvas bottom edge will be a narrower single layer to which the lead line will be fastened. Our doubled canvas channel housing for the leads pockets air which tends to reduce the effectiveness of the lead line.—GEORGE A. MOORE, *Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.*

SPAWNING RECORDS OF FISHES SELDOM REPORTED FROM NORTH CAROLINA WATERS.[1]—During the research cruise in North Carolina waters of the U.S. Fish and Wildlife Service vessel "Albatross III" specimens of several species of fishes were collected during the period January 16 to February 20, 1950, in which eggs were loose in the ovary and appeared to be fully mature. These species were *Calamus calamus,* the saucer-eye porgy; *Pagrus pagrus,* the red porgy; *Prionodes phoebe,* the phoebe; and *Rhomboplites aurorubens,* the vermilion snapper. Except for the phoebe, these species have been reported in North Carolina waters by Hildebrand (1941, COPEIA, (4): 227) from a few specimens collected over a period of more than 30 years. Although the normal range has been considered to be much farther south, the recent collections by the "Albatross III" indicate that all of the above species are not only relatively common but that these fishes also spawn in the warmer waters off North Carolina.—EARL T. WALKER, *U. S. Fish and Wildlife Laboratory, Beaufort, North Carolina.*

[1] Published by permission of the Fish and Wildlife Service, U. S. Department of the Interior.

NOTES ON THE EFFECT OF FLASH FLOOD ON STREAM FISH IN WEST VIRGINIA.—On June 17, 1949, a serious flash flood occurred in the South Branch River Valley of the Potomac River. In the Petersburg, West Virginia, section a total of 12.09 inches of rain fell in a 48-hour period, between midnight on June 16 and midnight June 18. Waters passing down the river valley of the South Branch were torrential, doing considerable damage to the stream bed in many places, and changing its course to some extent.

Prior to the flood, smallmouth black bass (*Micropterus dolomieu*), as usual, were known to have spawned twice during the month of May. The general angling public felt that most bass were lost during the flood, and that all bass fry and fingerling were destroyed, but I suspected that the bass might spawn again when waters receded. A field assistant (non-technical) was instructed to watch for spawning activities. He reported fish guarding redds on the tenth day following the day when waters had receded to their normal level. No seining was done to check this report; however, I feel certain that this individual made accurate observations.

On August 15, 1949, I had the opportunity of seining for young bass in the South Branch near Moorefield. The stream was again in flood stage, due to rain the previous day. However, flood levels were not more than several feet above the normal channel. Numerous minnows, some fingerling catfish, and many suckers and fingerling smallmouth bass were taken. The young bass measured from 25 to 30 mm. in length. Although not abundant in each seine haul, they were nevertheless quite common at this collecting station.

The question arises here, as to whether or not the smallmouth black bass spawned following the flood in order to compensate for losses of young which occurred in the flood. Water temperatures at the time of spawning were not taken. However, it is believed that other warm-water species also spawned subsequent to the June flood, for small fingerlings and fry of the green sunfish (*Lepomis cyanellus*), shiners (*Notropis* spp.), black bullhead (*Ameiurus melas*), and white sucker (*Catostomus commersonnii*) were also observed in seine hauls on August 15.—E. A. SEAMAN, *West Virginia Conservation Commission, Charleston, West Virginia.*

FLYING OF THE HALFBEAK, *EULEPTORHAMPHUS*.—One day during the summer of 1947, Dr. Leonard P. Schultz and I were members of a party in a small launch crossing the lagoon of Bikini Atoll, Marshall Islands. There was a brisk wind and the water was rough, with waves 6 to 8 feet high, necessitating bracing one's self to keep upright. We were near the middle of the lagoon and Dr. Schultz and I were standing together along the port rail when he suddenly pointed and cried out to me. I turned in time to see an adult *Euleptorhamphus longirostris*, entirely out of the water and flying, not over 50 feet from the boat's side. He had seen the fish emerge, but I had not.

The course of the fish was obliquely away from us, at an angle of perhaps 25° from the boat's course, and the point of emersion was less than 50 feet from the stern. The flight was into the wind and was as steady and well done as that of an exocoetid. The large pectoral fins were widely spread laterally and there was no tendency for the fish to turn over sidewise or waver in its flight. The front half of the body was kept rigidly horizontal, but from the middle of the long trunk backwards the body curved strongly downwards.

The fish just cleared several waves, and then was clearly seen to dip its tail into the water, "taxi" vigorously with the caudal fin, and resume its flight. It finally disappeared over a higher wave. The entire length of the observed part of the flight was estimated by me to be no less than 150 feet, and was almost certainly longer. Unfortunately it was not timed.

No hemiramphid fish has, to my knowledge, yet been reported to make so perfect a flight—entirely similar to that of the true flying fishes—although Dr. Schultz told me he had seen other flights of individual halfbeaks in the Marshall Islands. Later, from the high bridge of a ship in the same lagoon, I saw another halfbeak fly, but conditions were poor for observation.

There was no possibility of misidentification on the first occasion. The fish was near, the air was clear, and the long beak, compressed body, and large pectoral fins of *Euleptorhamphus* were unmistakable.—GEORGE S. MYERS, *Stanford University, California.*

Herpetological Notes

COLOR VARIANTS IN SNAKES FROM THE SOUTHEASTERN UNITED STATES.—On June 5, 1949, an unusual specimen of *Farancia abacura* was found smashed on U. S. Hwy. 90, 2 miles east of Milton, Santa Rosa County, Florida. The head and part of the tail were missing, but its length may be estimated at 15 inches. The skin was removed to study the pattern. (Fig. 1.)

Fig. 1. Abnormal coloration of *Farancia abacura* from Florida, shown in flat skin. Drawing by John Boley.

The venter was immaculate red, somewhat lighter than that of normal *Farancia;* black pigment was absent except where a number of ventrolateral black spots invaded the ventrals on the anterior half of the body. The unusual coloration may be described as follows: a wide, irregular black dorsal line extending for approximately a third of the body length, with a series of irregularly spaced ventrolateral black spots on either side of this line. Posterior to this is a similar, but more irregular, wide line of about half the length of the anterior one. The pattern of the remaining part of the body and tail consists of about 16 irregular, black blotches, most of which are transversely elongate. The dorsal ground color is of the same red as the venter. After two months in 10 per cent formalin, the red faded to a pink much lighter than that of normal *Farancia* preserved for the same length of time.

According to Smith (COPEIA, 1938: 117), specimens are occasionally found with tendencies toward reduction of black pigment, resulting in a banded aspect. This condition is especially noticeable in juveniles. However, the extreme reduction of black pigment, together with the lighter shade of red of both dorsal and ventral ground color, may indicate partial erythrism in this specimen.

On the basis of locality, the specimen should be referred to as an intergrade between *abacura* and *reinwardtii*.

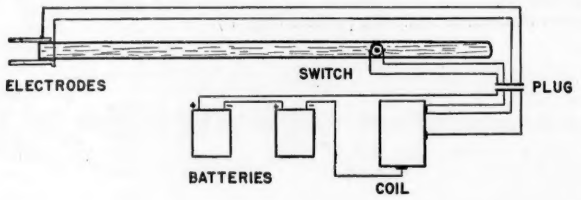
On June 15, 1949, an erythristic *Natrix sipedon compressicauda* was collected in the mangrove swamps of Marco Island, 5 miles south of Royal Palm Hammock, Collier County, Florida. The specimen, an adult female, measured snout to vent 384 mm., and tail 130 mm. The scutellation is normal for the subspecies. The specimen was a uniform pale orange dorsally with no indication of lateral stripes or crossbands. The supralabials were of the same orange and were margined with dark orange-red. The belly was white; the infralabials, gular shields, and lateral margins of the ventrals and subcaudals were also margined with dark orange-red. The eyes were pale blue.

After two months in 10 per cent formalin, the dorsal color faded to very light tan, and the orange-red margins of the labials, gulars, and ventrals disappeared.

In April, 1948, 2 melanistic *Natrix rigida* were collected by Mr. A. H. Chaney at Pearlington and Slidel, Tammany Parish, Louisiana. Both specimens were juveniles, and measure, respectively, 167 mm. snout to vent, 49 mm. tail, and 164 mm. snout to vent, 47 mm. tail. Melanism was complete, both specimens being entirely black, including the eyes. No change in color has been noted after twenty-one months preservation in alcohol.

The *Farancia abacura* and *Natrix sipedon compressicauda* are in the author's collection. Both of the specimens of *Natrix rigida* are in the Tulane University Research Collection.—RICHARD E. ETHERIDGE, *Tulane University, New Orleans, Louisiana.*

AN ELECTRICAL APPARATUS FOR HERPETOLOGICAL COLLECTING.—A simply constructed and inexpensive shocker has been found useful in collecting snakes (especially *Agkistrodon*), lizards, and amphibians in Louisiana. By attaching two 6-volt lantern batteries to a Ford Model T spark coil, very high voltages are obtained. When two electrodes are placed in contact with any part of the animal a temporary paralysis results. When very large snakes are immersed in water it is necessary to apply the shock to the anterior third of the body to obtain complete paralysis, but any contact will usually prevent escape. The shock is often fatal to small amphibians (especially *Hyla*) but other forms recover without apparent harm.



The diagram illustrates essential points of construction. The current is controlled by an ordinary doorbell button. The electrodes may be mounted on a special handle or on a rake. A four-prong plug makes for ease in storing, and allows one to use a rake with or without the shocker in operation. The batteries and coil may be carried on a heavy belt or in a knapsack. The electrodes consist of the bared ends of two wires leading from the coil. These are mounted on strong supports. If the latter are of metal they must be heavily taped to insulate the electrodes.

This device is useful when it is essential to collect large series of individuals.—PAUL K. ANDERSON and CLARENCE L. SMITH, *Department of Biology, Tulane University, New Orleans, Louisiana.*

THE PILOT BLACKSNAKE AND THE TIMBER RATTLESNAKE IN VERMONT.—Although the timber rattlesnake, *Crotalus horridus horridus* Linnaeus, has been assumed to occur in Vermont on the basis of early records, and on heads submitted for bounty payments (Trapido, 1941, New England Naturalist, No. 10), there have been no actual specimens of reliable source in collections to substantiate this distribution. It is notorious that specimens may be brought considerable distances to collect bounties, and it is not at all improbable that in the present instance some may have been brought from Massachusetts and New York.

In August, 1946, I observed and collected rattlesnakes among some rocky ledges in Rutland County, Vermont, about 6 miles northwest of Fair-Haven, and have taken specimens there on repeated visits every year since. There are examples now in both the American Museum of Natural History and the Staten Island Zoo of these Vermont specimens. Very dark or quite black seems to be the commonest adult color phase of both sexes; however, the largest specimen collected, a male, is an exceptionally brilliant example of the "sulphur" phase. Altogether, I have collected 21 adults and observed 12 additional specimens; among the latter was also a brood of newborn young.

Apparently this is no isolated population as might be supposed for there are local reports of rattlesnakes being found in the farm and timber country from the above locality to South Bay, New York, where they can connect with populations on the western shore of Lake Champlain. As recently as 1941, C. F. Kauffeld collected *C. h. horridus* above Westport in Essex County, New York, on the shores of Lake Champlain immediately across from Vermont. The "den" ledge at which the Vermont specimens were taken is at approximately 1000 feet elevation and may be considered to be in a spur of the Taconic Range and not the Green Mountains or Adirondacks.

At the same locality, I found the pilot blacksnake, *Elaphe obsoleta obsoleta* (Say). I have collected and observed 11 specimens since August 8, 1946. These are not only

first records for Vermont, but represent an extension of between 100 and 150 miles northward for the known range of this species in New England. Heretofore the Connecticut Valley of central Massachusetts has been considered the northern New England limit for this form, but its presence in central Vermont is now definitely established. As with the rattlesnakes, all examples show characters well within the normal limits of variation of the subspecies.—ANTON F. BAARSLAG, *165 Liberty Avenue, New Rochelle, New York.*

METHODS FOR COLLECTING MAPTURTLES.—During the summer of 1950, members of the Tulane University field expedition tried several methods of collecting specimens of *Graptemys* in Louisiana and Florida. Previous attempts during the past three years to collect these turtles, using hoop nets, basking traps, trot lines, set lines, and fish hooks nailed to basking logs yielded only occasional individuals. They did not respond to the usual bait or to crushed clams. Hand-collecting by wading the shore line was not practical because the turtles were not found in shallow water.

Hand-collecting from a boat in the Pearl River near Angie, Louisiana (June 1–7) yielded as many as 34 specimens of *Graptemys pulcra* and *G. oculifera* in a single night. A 12-foot plywood hull powered by a 7.2 horsepower Martin outboard motor was used. This type of motor was especially suited for this work because the 360° type of steering provides great maneuverability. The river near Angie is approximately 100 yards wide and has a very rapid current. The boat was maneuvered along the shore line while the person in the bow collected the turtles by hand from their resting position just below the surface of the water. The use of a dip net was impractical as it could not be manipulated among the branches of the trees. Most of the turtles were found in quiet water on limbs of trees that had fallen into the water or on driftwood that had lodged against these trees. Large female turtles, although they were seen during the day, were not collected in the described manner at this locality. Visibility was restricted to a depth of 1 foot and the larger turtles probably rest at a greater depth. It was noted that if the beam of a three-cell head lamp was held on the turtles for a few seconds they would leave. The best collecting areas were located during the day by spotting aggregations of basking turtles. In 26 collecting hours, covering 5.6 miles of the Pearl River, 64 specimens of *Graptemys,* 9 of *Pseudemys s. scripta x troostii,* 4 of *P. floridana mobilensis,* and 4 of *Sternotherus carinatus* were collected.

This same technique yielded approximately 175 specimens of *Graptemys p. pseudogeographica* and *G. p. kohnii* from 3 miles of the Ouachita River near Harrisonburg, Louisiana, on June 10–16 (24 collecting hours). All sizes of both sexes were collected. One *Macrochelys temminckii,* weighing 20 lbs., 1 *Chelydra serpentina,* 17 specimens of *Pseudemys s. troostii,* 3 of *Sternotherus carinatus,* and 2 of *Pseudemys f. mobilensis* were also caught in this manner.

Collecting along 5 miles of the Sabine River near Negreet, Louisiana, yielded 325 specimens of *Graptemys p. pseudogeographica* and *G. p. kohnii* on the nights of July 5–7 (21 collecting hours). Three juvenile specimens of *Macrochelys temminckii,* 3 of *Sternotherus carinatus,* 2 of *Pseudemys s. troostii,* 2 of *P. f. mobilensis,* and 1 *Amyda spinifera* were also caught.

The same method used in Louisiana was not successful in the Chipola River near Marianna, Florida (July 12–14). Only 5 juveniles were collected in five hours on the first night. Carr and Marchand (1942, Proc. New Eng. Zool. Club, 20: 95–100) collected 76 specimens of *Graptemys barbouri* by using a face mask and swimming after them in the clear water. This method was attempted by the authors with very little success. Occasionally during the day it was possible to maneuver the boat up to basking juvenile turtles and catch them in a dip net as they fell from their resting spots.

A few large turtles had been observed swimming at the surface in the first attempt at night collecting, but no significance was attached to this. On the following night turtles were again noticed swimming at the surface as the boat was maneuvered from shore to shore. These were pursued and taken easily by hand from the bow of the boat. Further efforts revealed that the *Graptemys,* possibly disturbed by the motor, would swim toward the boat. Occasionally one would swim into the propeller. By heading the boat down stream and steering it from bank to bank, frequently reversing the motor, the turtles pursuing the boat would be swept past by the swift current and could be caught

by the person in the bow. After a little practice the operator of the motor learned to follow the movements of the person reaching for the turtles and could thus successfully outmaneuver them. Many individuals surfaced alongside the boat and were captured by the operator of the boat while the person in the bow was also catching turtles. At times 8 or 9 specimens of *Graptemys* were seen around the boat. One hundred and twenty-five specimens of *Graptemys* were caught in 5 hours on July 13. The following night 257 more were collected in 8 hours from approximately 4 miles of the river including the two-and-one-half-mile section that had been worked the preceeding night. Turtles collected by this method ranged from 60 to 300 mm. in carapace length. The only other species caught in this manner was one *Macrochelys* weighing 25 lbs.

These collecting procedures have yielded, for the first time, samples of *Graptemys* adequate for the definition of the status of the Gulf Coast populations. The specimens are deposited in the Tulane collections where they are being utilized in an analysis of the variation in this genus. The identifications reported here should be regarded as tentative since a preliminary study of the collections clearly indicates the need for substantial changes in the nomenclature of the members of this complex group.—ALLAN CHANEY and CLARENCE L. SMITH, *Department of Zoology, Tulane University, New Orleans, Louisiana.*

LEOPARD FROGS IN CAVES IN WINTER.—Leopard frogs (*Rana pipiens*) in northern latitudes are said to spend the winter, ordinarily, hibernating in the mud in the bottom of ponds. Observations made December 10, 1949, near Bedford, Lawrence County, Indiana, where limestone caves are common, suggest that this species may winter in caves when this situation is available.

Five caves were visited, all of which had streams flowing through them. Frogs were found in two of these caves. In Clifty Cave, about 200 feet inside the entrance, well beyond the twilight zone and in complete darkness, I found in the cave wall a crevice in which were at least 5 frogs. The crevice was too small to admit my hand, but when a light was shined into it 2 of the frogs hopped to the entrance and were collected. About 5 feet beyond was another crevice with 2 frogs and close by another with one frog, all *Rana pipiens*. In Donaldson's Cave, about 150 feet inside the entrance, well beyond the twilight zone, a single frog of the same species was found on the floor of the cave. Though winter conditions prevailed outside, none of these frogs was dormant but all were capable of moderate activity.—A. S. RAND, *Chesterton, Indiana.*

THE SALAMANDER *AMPHIUMA TRIDACTYLUM* IN OKLAHOMA.[1]—On June 18, 1948, a single specimen of the lamper eel, *Amphiuma tridactylum*, was collected at Grassy Lake, Sec. 35, T. 6 S., R. 26 E., which is southeast of Broken Bow, McCurtain County, Oklahoma. *Amphiuma* has not previously been reported from Oklahoma, but the regional habitat fulfills the needs of the species.

The specimen was found on the bank of the lake in the jaws of a female mudsnake, *Farancia abacura reinwardtii*. This snake feeds almost exclusively upon *Amphiuma*, and their ranges are therefore practically coextensive. The previously known range of *Amphiuma tridactylum* includes the Coastal Plain of Alabama, Mississippi, Louisiana, and eastern Texas, and the Mississippi River Valley to Arkansas, Tennessee, and Missouri. This new record extends the range sufficiently to include the southeastern corner of Oklahoma, which lies within the Coastal Plain, and ranges from 300 to 500 feet in elevation.

Grassy Lake, although relatively small, is a permanent body of water surrounded by bald cypress, *Taxodium distichum*, sweet gum, *Liquidambar styraciflua*, and sycamore, *Platanus occidentalis*, with the yellow water lily, *Nymphaea advena*, growing about the edges. On one side of the lake there is a swamp that runs nearly the extent of the lake and is covered with dense underbrush. Several specimens of the cottonmouth, *Agkistrodon piscivorous*, were taken along with some watersnakes, *Natrix sipedon confluens*.

Until recent years this part of Oklahoma was rather inaccessible, and lacked extensive biological study. Since this area is quite comparable to others where *Amphiuma* is abundant, further collections may show the lamper eel to be common in the Oklahoma portion of the Coastal Plain.—MILTON R. CURD, *Department of Zoology, Oklahoma A. and M. College, Stillwater, Oklahoma.*

[1] Contribution No. 148, Zoology Department, Oklahoma Agricultural and Mechanical College.

REVIEWS AND COMMENTS

AMPHIBIANS OF WESTERN CHINA. By Ch'eng-chao Liu. Fieldiana: Zoology Memoirs, vol. 2 (quarto, 400 pp., frontispiece, 10 plates, 8 colored, 100 text figures). Chicago Natural History Museum, June, 1950.—This magnificent volume is the culmination of 20 years' work by China's foremost batrachologist, who began his career under America's senior and best-loved student of batrachian life-histories, Dr. A. H. Wright of Cornell. It covers the classification, distribution, habits and life-histories of the salamanders and frogs of one of the least known parts of the earth. The work is excellent, the illustrations are numerous and good, and the size and format of the book are impressive. Above all, a great deal of the material presented, especially that on life-histories and tadpoles, is entirely new and intensely interesting, and makes this volume a very important contribution to knowledge of the world's amphibians.

There are sections on preservation and measurements, localities mentioned, the explorations of the author in Sikang, Szechuan, and Chinese Tibet (a most interesting account), distribution and adaptations, and finally the descriptions and life-history accounts for each species. There are many illustrations of tadpoles and adults, the colored plates of live animals being especially fine. The treatment is very full and is presented in an excellent way. There are keys to both adults and tadpoles of some genera. The one really serious omission is the absence of descriptions, discussions, and keys for the genera and families, a fault which most effectively prevents use of the book as a complete systematic manual. For example, the reviewer confidently expected this volume to give him the generic characters of Dr. Liu's genus *Vibrissaphora,* whose description is buried in an obscure West China journal quite unavailable in most university libraries, and he was both surprised and nettled to find not even a heading for the genus! A half-dozen pages would have sufficed to improve the systematic usefulness of the monograph about 100 per cent.

It is to be expected that comparisons will be made between this volume and Bourret's 1942 monograph of Indo-Chinese amphibians which this reviewer noticed recently in COPEIA. The size of the books is comparable although Bourret's has more text due to the smaller type. Each suffers in some ways on comparison. Bourret covered a much larger fauna, but at least half of his work was compiled. His field work was practically confined to two or three localities in Tonkin. The amount of literature he had to digest was prodigious, but he did it fairly well, even though he missed some very important papers, due perhaps to his working in almost complete herpetological isolation. Liu's work, on the contrary, is almost all his own, is based on far more extensive and intensive field work, and is done in a much better, less cut-and-dried manner. The literature he had to consider was not too extensive and he considered it in impeccable fashion, due perhaps to his being able to work at a great museum under the guidance of most able herpetologists. But Bourret's book is the more useful to a foreign herpetologist attempting to gain an initial or general knowledge of the fauna covered, not only because he did not omit keys but also because he tried hard to produce a work that would obviate the need for supplementary literature—a most important point not always remembered by systematists working at well-outfitted centers of research.

Finally, this monograph provides one more reason for pointing out that the herpetological fauna of Asia is now more extensively and recently monographed than that of any other continent save perhaps Europe. Since 1915, the monographs of Boulenger, Nikolsky, de Rooij, Wall, Taylor, Malcolm Smith, Maki, Sato, Bourret, Pope, Okada, and now Liu, have covered most groups and almost all areas of the continent save the southwest and the Tibetan Plateau. Would that North America were as well provided! —GEORGE S. MYERS, *Natural History Museum, Stanford University, California.*

EDITORIAL NOTES AND NEWS

Report of the Committee on Fish Classification

THE COMMITTEE ON FISH CLASSIFICATION, appointed by PRESIDENT NETTING last spring, held two sessions at Salt Lake City, under the chairmanship of G. S. MYERS. Attending were the following Committee members: R. M. BAILEY, R. L. BOLIN, C. L. HUBBS, G. S. MYERS, E. C. RANEY, L. P. SCHULTZ, J. TEE-VAN. Absent: A. E. PARR. N. J. WILIMOVSKY was appointed secretary *pro tempore* for these meetings. Both meetings were open to interested members, whose opinions were freely sought by the Committee.

The first meeting at 1:30 P.M., July 21, in Room 207, Biology Bldg., considered certain groupings of lower chordates, without reference to names. It was agreed that the Committee adopt two main divisions of craniates, the agnathous and gnathostome groups, the latter to include all higher classes, and three classes of fishlike gnathostomes (placoderms, plagiostomes, and bony fishes). On the basis of evidence submitted by MYERS, it was moved and carried that the use of superordinal divisions among the lower actinopterygian orders be omitted. It was likewise decided that the haplomous fishes be reduced to a suborder of the isospondylous order and that the ostariophysan groups be kept as a single order. The order Apodes (as of Regan) was retained, although with expressed doubt as to its monophyletic nature, and inclusion of the lyopomous fishes with the order Heteromi was agreed upon. Decisions regarding the subordinal grouping of the isospondylous and iniomous fishes were reserved for later decision. N. J. WILIMOVSKY and R. R. HARRY were requested to prepare bibliographies on these two orders, respectively, for Committee use. Discussion concerning families was also deferred. TEE-VAN expressed the hope that the Committee might be continued as a permanent feature of the Society's work, more or less comparable to the "Checklist Committee" of the A. O. U., to sift and give opinions on proposed major changes in fish classification. MYERS indicated the need for study of fossil fish classification.

The second meeting of the Committee, held in the same place at 9:00 A.M., June 22, took up the nomenclature of superior categories. MYERS pointed out that any decisions as to methods of naming were subject to change in line with future decisions of the International Zoological Congresses. L. P. SCHULTZ then read his paper, "Results of a recent survey of zoological opinion on stabilization of group endings." Much discussion followed. Voting, both of the Committee and the group as a whole, resulted in approval of: (1) Utilization of the stem of the type genus in formation of names of all categories from subtribe to superorder; (2) utilization of the endings proposed by Stenzel in "Proposed uniform endings for names of higher categories in zoological systematics" (1950, Science, 112: 94). These are as follows: Subtribe, -ini; Tribe, -idi; Supertribe, -ici; Subfamily, -inae; Family, -idae; Superfamily, -icae; Suborder, -ina; Order, -ida; Superorder, -ica. The few herpetologists present, and a minority of the ichthyologists, were opposed to uniform endings for orders and superorders.

Uniform endings for categorical names above superorder were opposed by a unanimous vote of Committee and audience. A motion that priority not be a compelling factor in selecting higher group names was carried. It was decided to poll the Society membership concerning several of these decisions. Moved, seconded and carried to thank L. P. SCHULTZ for his efforts in studying group endings, and G. S. MYERS for work in preparing the three Committee circulars.

The Committee then considered certain names for lower vertebrate groups previously adopted. The following classification indicates the names approved by the Committee, with the cognate names that were disapproved shown in parentheses. Names in square brackets were not voted on.

[Phylum *Chordata*]
Subphylum *Vertebrata* (*Craniata* rejected)
Superclass *Agnatha* (*Marsipobranchii, Cyclostomata* rejected)
[Class *Monorhina*]
Subclass *Cyclostomi* (*Marsipobranchii, Cyclostomata* rejected; latter preferred by meeting as a whole but not by Committee.)
Superclass *Gnathostomata* (*Gnathostomi* rejected.)
Class *Placodermi* (*Aphetohyoidea* rejected.)
Class *Chondrichthyes* (*Chondropterygii, Plagiostomi, Plagiostomata, Elasmobranchii* rejected.)
Class *Osteichthyes* (*Pisces* rejected.)
Subclass *Choanichthyes* (*Amphibioidei* rejected.)
Subclass *Teleostomi* (*Actinopterygii, Actinopteri* rejected.)
[Class Amphibia, etc.]

For the benefit of those members not yet familiar with the work of the Committee on Fish Classification, the following statement has been prepared by PRESIDENT MYERS: The Committee was set up in the autumn of 1949 by JOHN TEE-VAN, editor-in-chief of the cooperative work, "Fishes of the Western North Atlantic," to advise the editors of that work in regard to the major classification of recent bony fishes to be adopted in the succeeding volumes. C. L. HUBBS and G. S. MYERS suggested that the scope of the Committee's work be enlarged to include all fishes, living and fossil, and that it be taken over by the A.S.I.H. to prepare a new outline of fish classification, eventually to be published in COPEIA. The committee, as constituted in the spring of 1950, was appointed, without change of membership, as a Committee of the Society by PRESIDENT NETTING. During the winter and spring of 1949-50, CHAIRMAN MYERS prepared circulars for the Committee, outlining its work and providing background material. Unfortunately, the historical survey of recent and fossil groupings and names was placed in the Committee's hands only at Salt Lake City, too late for careful study and appraisal.

Following the suggestions of TEE-VAN and others, it is possible that the Committee may be continued, beyond the time necessary to complete its immediate objective, to study improvements and new developments in fish classification.

Tulane University

FRED R. CAGLE has been promoted to Professor of Zoology and Chairman of the Graduate Department of Zoology. ROYAL D. SUTTKUS has been appointed Assistant Professor of Zoology (Ichthyology). In the zoology department doctoral research on cold-blooded vertebrates is being done by A. H. CHANEY: A comparative study of populations of *Desmognathus* in Louisiana; JOYCE SIEKMANN: The breeding behavior of *Hyla avivoca.* Master's research is being conducted by CLARENCE SMITH: The effect of water hyacinth mats and their removal on fish populations; PAUL ANDERSON: The life history of *Microhyla carolinensis;* JEAN HILL: An analysis of amphiuma populations; RICHARD JOHNSON: The reproductive habits of *Leiolopisma.* The status of *Coluber constrictor anthicus* is being investigated by RICHARD ETHERIDGE, undergraduate. Through the generosity of LEON SARPY, New Orleans attorney, Tulane has established a 2,000-acre swamp area for the study of fish, amphibian and reptile populations. It has been named the SARPY WILDLIFE RESEARCH REFUGE.

University of Oregon

MASTER's theses have been submitted by R. W. KELLY: A preliminary ecological survey of a temporary pond in a Douglas Fir forest association, with emphasis on the food and feeding habits of the Oregon newt, *Triturus granulosus granulosus;* and M. N. DE MARCO: A preliminary study of certain features of the comparative anatomy of *Dicamptodon ensatus* and *Necturus maculosus.* The latter study was concerned with the problem of neoteny. Both students did their work in the Biology Department under the direction of A. S. LOCKLEY.

News Notes

DR. W. E. RICKER was recently appointed Editor of Publications for the Fisheries Research Board of Canada and is stationed at Nanaimo, British Columbia. The several publications under his jurisdiction report results of investigations carried out at the four Biological Stations (Nanaimo, Winnipeg, St. Andrews and St. John's) and three Experimental Stations (Vancouver,

Grande Rivière and Halifax—all technological). In addition, he acts as consultant for work at the Pacific Biological Station and still finds time to do some independent research work.

MR. MAX A. PROFFITT, formerly Teaching Fellow in the Department of Zoology, University of Michigan, has taken an appointment as Assistant Professor of Biology at John Milligan University, Decatur, Illinois.

MR. WILLIAM A. TOMPKINS, formerly Teaching and Research Assistant in the University of Michigan, has taken the position of Chief Fishery Biologist with the Division of Game and Fish, Frankfort, Kentucky.

On September 1, 1950, a new Department of Fisheries was formed in the University of Michigan. This department is part of the also new School of Natural Resources which combines the fishery work formerly carried on in the Department of Zoology with the forestry and wildlife activities pursued in the former School of Forestry and Conservation. DR. KARL F. LAGLER is chairman of the new fish unit and Associate Professor of Fisheries and of Zoology. DR. JOHN VAN OOSTEN, Fishery Research Biologist of the U. S. Fish and Wildlife Service, has been appointed lecturer in commercial fisheries.

DR. R. W. ESCHMEYER recently resigned from his position as fishery biologist with T. V. A., Norris, Tenn., where he has made an outstanding contribution to the progress of fish management, particularly in the field of liberalizing fishing regulations, and he is now Executive Vice-President of the national Sport Fishing Institute, 430 Bond Bldg., Washington, D. C. His new duties will be to promote, encourage and assist the numerous state, national and educational agencies and institutions which are concerned with fishery conservation, management and research, to encourage cooperation between these agencies, and to publish and distribute information about significant developments in fish management.

VIRGIL S. PRATT has concluded his doctoral field work (ecology of trout streams of southern Michigan) with the Institute for Fisheries Research at the University of Michigan. He is now Assistant Professor of Zoology, Cooperative Wildlife Research Unit, University of Idaho, Moscow, Idaho.

An anonymous donor has forwarded $25 to be used for awards of $12.50 each to HARRY W. FREEMAN, Natural History Museum, Stanford, California, for his paper "Some Results of Phylogenetic Studies on Agonid Fishes" and to NORMAN J. WILIMOVSKY, Hopkins Marine Station, Pacific Grove, California, for his paper on "The Status of the Blennioid Genera, *Epigeichthys* and *Xiphister*," both of which were given at the recent Salt Lake City meetings. The donor felt that these papers were of unusual merit, as did the members of the Prize Award Committee.

DR. KATSUZO KURONUMA, who was appointed Director of the Freshwater Fisheries Station at Tsukishima, Japan, last fall, spent June, July and August in the United States. His mission in this country was part of the SCAP program for the exchange of national leaders that is being administered by the U. S. Fish and Wildlife Service. DR. KURONUMA visited fish and fishery centers in Washington, Oregon, California, Utah, Tennessee, Washington, D. C., New York, Massachusetts, Michigan and Illinois.

DR. GEORGE S. MYERS was away from Stanford University from September 2 to October 20 on a flying visit to Brazil. He conferred with officials at the Museu Nacional, Rio de Janeiro, concerning the "Survey of Brazilian Marine Fishes of Commercial Importance," of which he is Director.

Word is received that Hafner Publishing Company, Inc., 31 E. 10th Street, New York 3, New York, have a stock of the 2nd edition of J. L. B. Smith: The Sea Fishes of Southern Africa (reviewed in COPEIA, 1950 (2): 158), at $15.00 plus postage. DR. SMITH writes to advise that the book can be purchased for $8.00 from the Central News Agency, Ltd., Capetown, South Africa.

DR. W. C. ALLEE has retired from the University of Chicago to accept the position of Chairman of the Department of Biology at the University of Florida, effective September 1, 1950.

The new editor of *California Fish and Game* is MR. PHIL M. ROEDEL. Communications should be addressed to him at the California State Fisheries Laboratory, Terminal Island, California.

The Secretary of our Society is interested in purchasing both short and long runs of COPEIA to be used to complete sets for sale to libraries and to members.

DR. BRUCE HALSTEAD, medical zoologist of the School of Tropical and Preventive Medicine, Loma Linda, California, was one of seven scientists who, under the direction of CAPT. ALLAN HANCOCK, explored the west coast of Baja California on a 19-day cruise aboard the *Velero IV* during the month of May. DR. HALSTEAD was concerned with the identification of poisonous fishes. DR. E. YALE DAWSON and DR. JOHN S. GARTH of the University of Southern California Hancock Foundation conducted studies in charting marine plant life and in making continuous recordings of water temperatures at various depths. DR. MAURICE NELLES, marine research engineer, was assisted by JERRY BARNARD and CLARENCE CLEVER of the Foundation.

DR. T. H. JARVI, distinguished Finnish fishery biologist, has retired, and in his place DR. ERKKI HALME has been appointed. DR. HALME'S address and that of Dr. JARVI, who is continuing his researches, is: Mariank. 23, Maataloushallitus, Helsinki, Finland.

MR. and MRS. LEWIS H. BABBITT were curators in charge of the Junior Museum of Miami, Inc., Miami, Florida, from April 15 to June 15, 1950. During this period they presented illustrated lectures to some 15,000 Dade County school children.

DR. HANS THEODOR RUST, 44, died on June 22, 1950, in Munich, Germany.

RODGERS D. HAMILTON, of the Arctic Research Laboratory, under contract with the Office of Naval Research, has been given up as lost, according to an Associated Press Dispatch release dated October 1, 1950. HAMILTON was one of the personnel attached to an arctic survival research project which Johns Hopkins University is conducting for the Navy Department.

On May 9, 1950, HAMILTON and his pilot left Tiiguarik Island on a flight to Point Barrow, Alaska. The airplane never reached its destination, and no trace of it or its occupants has been found.

HAMILTON was a graduate of the University of Pittsburgh, and did graduate work in Zoology at the University of Rochester and later at the University of Michigan where he studied toward the doctorate. He had completed a preliminary draft of his thesis, a study of the ecology and distribution of the northern woodfrog, and had spent considerable time in Alaska and in Yukon and Northwest Territories pursuing his studies on a fellowship granted him for that purpose by the Arctic Institute of North America. He stated in one of his last letters that he planned to return to the University of Michigan in July (1950) to finish his doctoral thesis. He was thirty years old at the time of his disappearance.

W. A. GOSLINE reports that he received a letter, dated April 6, 1950, from L. S. BERG who states that he is now working on a revision of the book "Classification of Fishes" for a new and enlarged edition. Also, he reports that the fourth edition of "Fresh Water Fishes of the U.S.S.R." was published in three volumes during 1948 and 1949.

DR. DAVID G. FREY has resigned from the University of North Carolina to accept the appointments, at Indiana University, of Associate Professor of Zoology, Director of the Indiana Lake and Stream Survey, and Director of the Biological Station at Winona Lake.

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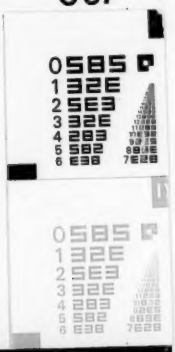
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